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Sand cays of eastern Guadalcanal

By D. R. Stoddart

Department of Geography, University of Cambridge

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1. Introduction

The cays and reefs of eastern Guadalcanal have never been described, and are hardly referred to in the literature. Brenchley (1873, pp. 274–276) visited Marau Sound in H.M.S. *Curacoa* in September 1865, but made no observations of value; Guppy unfortunately did not call there; and the work of the Geological Survey of the British Solomon Islands has been confined to the high islands. There is brief mention of some of the cays in the *Pacific Islands Pilot*, but in effect the cays of east Guadalcanal were unknown at the time of this study.

With the exception of studies by Umbgrove (1928, 1947) and Kuenen (1933) in the East Indies, studies of reef islands have largely been carried out on open-ocean atolls or on barrier reefs. Island morphology in these areas has been shown to be dependent on barrier reef geometry and wave energy, the most diverse island types being found in barrier reef areas with a wide range of energy conditions (Steers 1929, 1937; Spender 1930; Stoddart 1965). It had been expected that the Melanesian reefs, with their diverse topography, would show a similar range of island form. Several workers have also attached great importance to a presumed recent negative shift of sea level, both in originating many surface features of reefs and in permitting island accumulation on abnormally high reef flats (Gardiner 1931; Sewell 1935; Cloud 1954). It is doubtful whether such a negative shift in sea level did occur, at least in the Holocene (Shepard *et al.* 1967), and it was thus of interest to study Melanesian reef islands formed in an area of recent tectonic uplift, local emergence simulating conditions once thought to be more general.

Marau Sound, east Guadalcanal, was visited by the Marine Party of the Royal Society Expedition to the British Solomon Islands from 15 September to 11 October 1965. A base camp was established at Paruru, on the mainland. Seventeen islands on the Marau Sound reefs were visited and mapped by compass traverse and pacing. Sediment samples were collected from beaches and also from the floors of inter-reef channels. One hundred and six numbers of plants were taken on the cays, and identified by Dr F. R. Fosberg of the Smithsonian Institution.

2. Structure and topography

Guadalcanal consists of a basement complex of igneous and metamorphic rocks of late Mesozoic-early Tertiary age. The basement rocks are intruded and overlain by Upper Eocene and Oligocene andesitic lavas, with some basalts; and this volcanic period was followed by prolonged subsidence and the accumulation of limestones, tuffs and clastic rocks. The whole island is shattered by high-angle faults, mostly trending 80 to 100° or 145 to 160°, giving a block-faulted relief with a maximum altitude of 2439 m in Mt Popomanaseu. The relief is asymmetric, with high relief close to the fault-delineated south coast and a more gentle fall northwards under Tertiary sediments. The Tertiary subsidence and sedimentation has been interrupted by irregular uplift, which has carried Miocene to Recent sediments well above sea level.

Little is known of the geology of eastern Guadalcanal. The uplands consist of basement schists, overlapped northward by Miocene limestone. According to Grover (1958, p. 30), the limestone falls from 670 m on hill tops inland from Kau Kau to sea level at Marau Sound. A linear belt of ultrabasic rocks (serpentinites) outcrops over a distance of 16 km on the Guadalcanal mainland and extends to Beagle Islands in Marau Sound (Thompson 1965*a*, p. 33, 1965*b*, p. 153; Grover 1958; Grover & Pudsey-Dawson, 1958, p. 60).

Marau Sound itself is the foundered eastern end of Guadalcanal (figures 112 and 113, plate 62). The east Guadalcanal mountains plunge beneath a narrow coastal plain, and re-emerge as the partially drowned high islands of Beagle (222·5 m), Malapa (184 m), Tawaihi (98 m), and Komachu (201 m). The igneous rocks are mantled with recent reef limestones, the outermost forming an interrupted and partially submerged barrier reef extending from the south coast fringing reef through Lauvie, Southeast, Horohato and Round Islands to the north coast fringing reef. Several large reef flats are found within this barrier: some carry typical sand cays, such as Niu, Maraunibina and Paipai, others have small residual nubbins of igneous rocks round which cays have accumulated (Keura, Pelakauro). The high islands themselves have fringing reefs, which in some cases are wide enough to carry cays, often formed round igneous residuals (East, Cimiruka, Sandfly). Outside the barrier there are further reef patches. Three on the north side carry small sand cays (Pari, Symons and North Islands). The relationship of these patches to the main barrier is obscure. One further patch lies 1·6 km east of Southeast Island (Taunu Shoal), and carries 3·5 m of water.

Within the Sound, channel depths generally increase from west to east, and towards the barrier entrances. Many of the western channels have depths of 35 m or less, while those east of Malapa are deeper than 65 m. Because of malfunction of echo-sounding equipment we could add no bathymetric data to the published chart, surveyed in 1879 (Chart 3413).

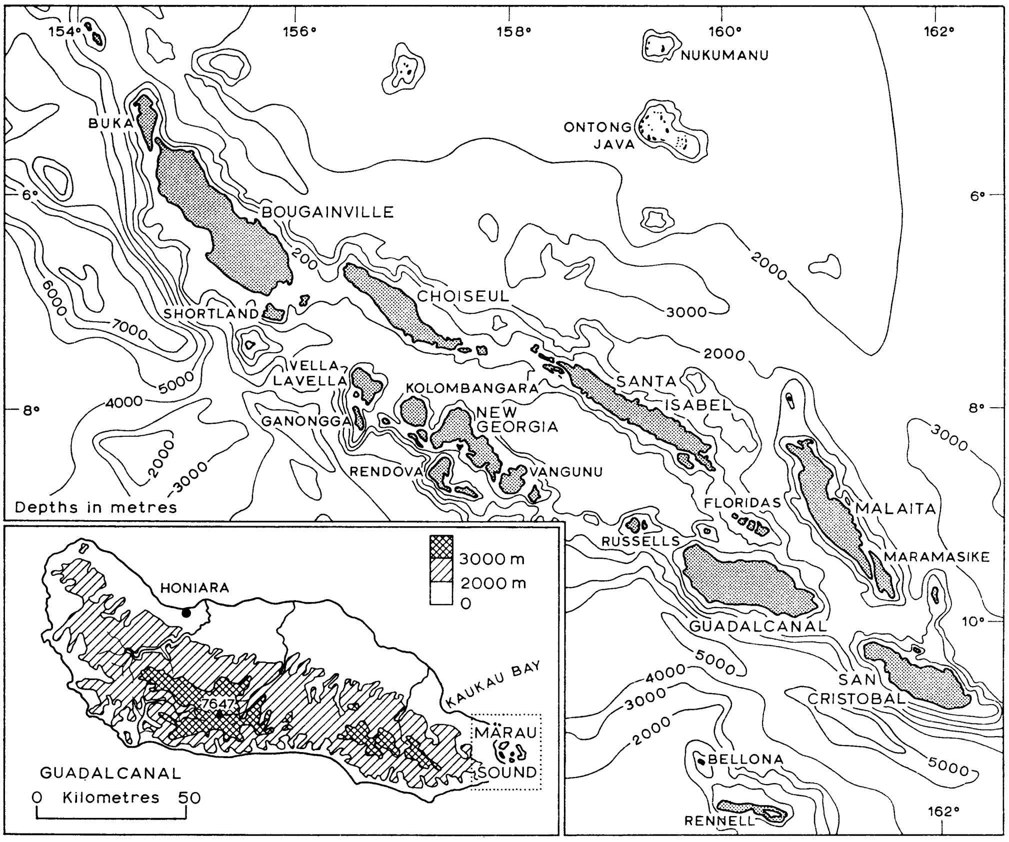

Figure 90. The British Solomon Islands, showing the location of Guadalcanal and Marau Sound

The Solomon Islands lie in a zone of considerable seismic activity, with shallow-focus shocks concentrated on the south side of the chain (Stoddart 1969): the San Cristobal Trench, anomalously on the continental (Australian) side of the arc, has depths of 5000 to 6000 m only 50 to 80 km south of the islands. A number of epicentres of recent earthquakes cluster in the channel between Guadalcanal and San Cristobal, and Grover (1965, p. 188) has described how, during the earthquake of 1 August 1961, magnitude $6\frac{1}{2}$ to $6\frac{3}{4}$ on the Gutenberg scale, reefs and mangroves were elevated by 0·6 m in Marau Sound. It is clear that the eastward tilting of the Sound is still continuing.

3. Climate and marine environment

In common with the rest of the Solomon Islands, east Guadalcanal is hot and humid, though climatic records throughout the group are scattered, discontinuous, and form an insufficient basis for theoretical understanding. The Intertropical Convergence Zone migrates latitudinally across the area during the year: south-easterly airstreams bring heavy rain, especially on mountainous south-east-facing slopes, during the middle of the year (July to August), and equatorial air-masses with less well-developed circulation patterns bring rain at the beginning and end of the year. Whereas much of Melanesia has a rainfall maximum in December to March (as at Honiara, north coast of Guadalcanal), many of

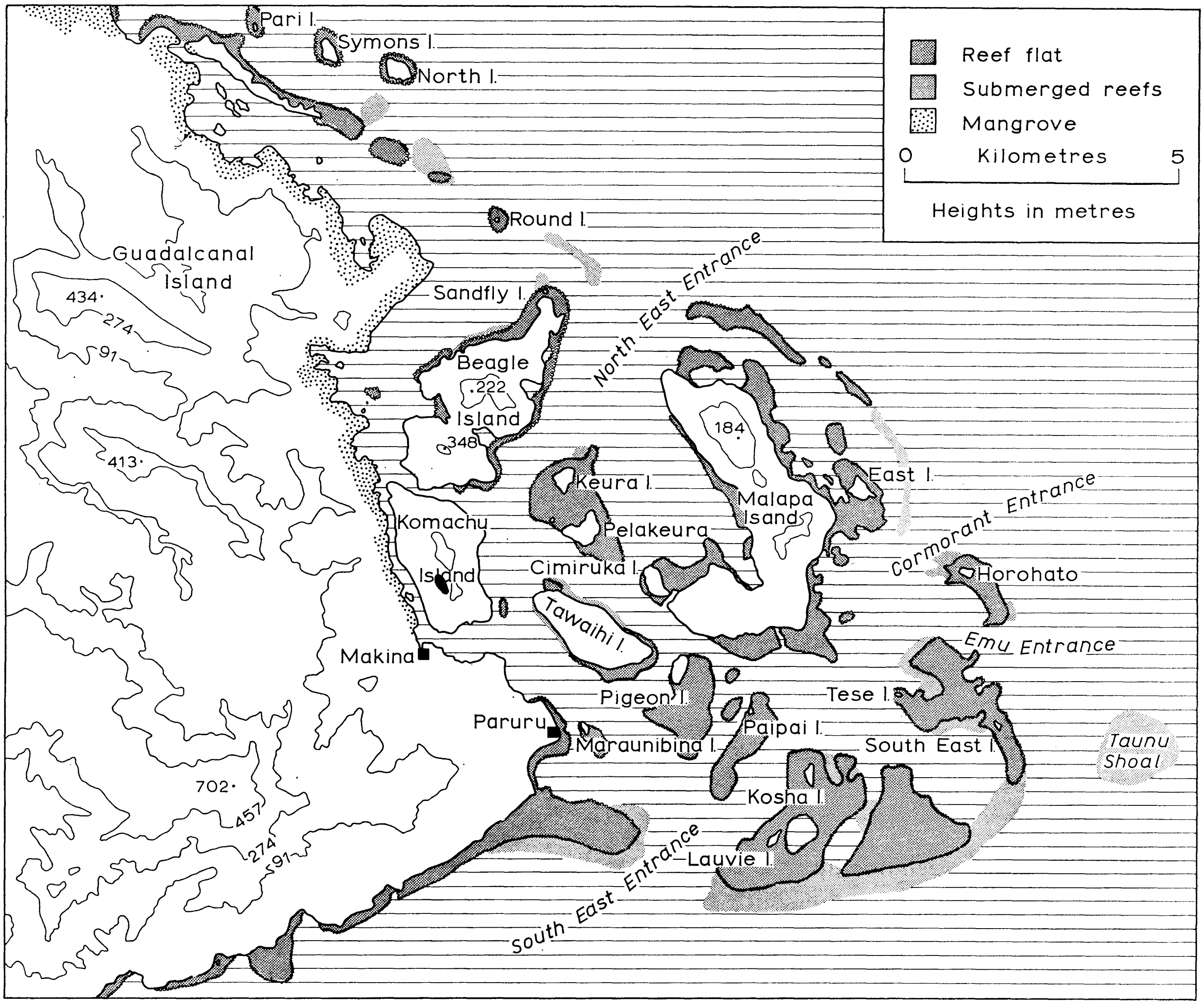

FIGURE 91. Marau Sound, east Guadalcanal.

the wetter areas, deriving rainfall orographically from the south-easterlies, have a maximum in mid-year. Areas affected by the south-easterlies also show much more pronounced rain-shadow effects than those whose rainfall comes from equatorial air masses. Mean monthly temperatures at sea-level stations vary from 27 to 28 °C, with a diurnal range of 5 to 7 °C. Absolute maxima and minima are roughly 35 and 20 °C.

The Solomons lie to the north of the south-west Pacific tropical cyclone belt. Most cyclones form to the east, in the Fiji–Ellice area, and move south and west; others form in the Solomons and move in the same directions. Near Guadalcanal they are generally small, though intense, features, capable of generating destructive wave action (Grover 1955, p. 5): the Marau Sound area was affected by a cyclone in 1966, after the observations reported here.

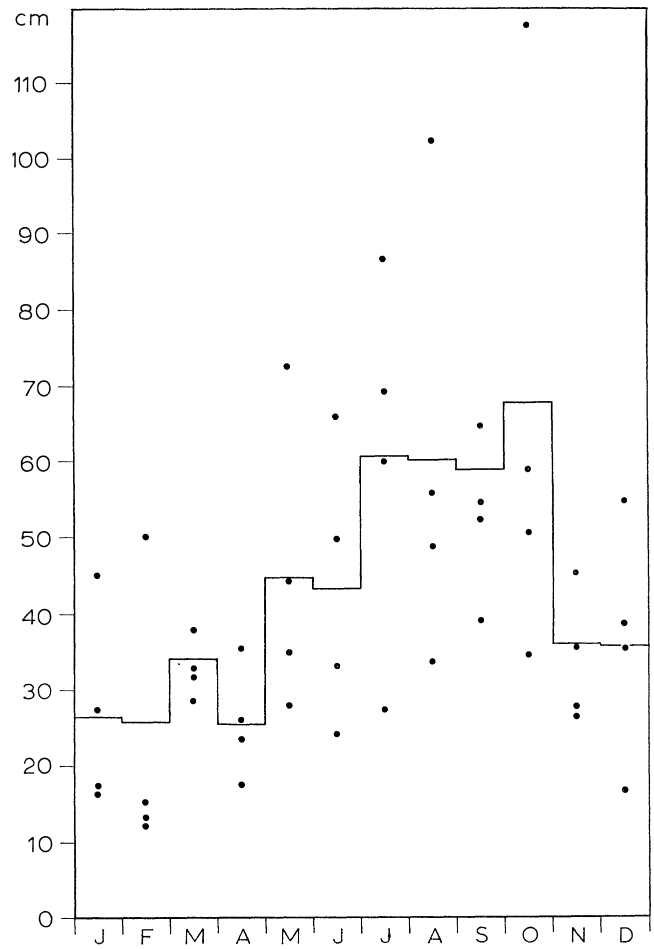

FIGURE 92. Monthly rainfall at Makina, Marau Sound, 1962–5.

3·1. *Rainfall*

Most Guadalcanal rainfall records are for north coast stations (Brookfield & Hart 1966). The nearest station to Marau Sound is at Kau Kau, with 28 y of recording ending in 1937. The mean annual rainfall over this period was 4453 mm, and median 4077 mm. Seasonal maximum occurred in July to September, with a pronounced (though wet) minimum in December to April. Fitzpatrick, Hart & Brookfield (1966) classify eastern and windward Guadalcanal as 'continuously wet' on the basis of these records.

The mission station at Makina, Marau Sound, has maintained rainfall records since January 1962. It is known that 23 to 29 y of recording are required for a stable median annual rainfall to emerge in the south-west Pacific, and rather longer for a stable mean (Fitzpatrick *et al.* 1966, p. 184), and the Makina records are thus inadequate for generalization. The seasonal distribution of rainfall is similar to that for Kau Kau, except that the months July to October are wetter (table 23). Rainfall varies from 250 to 380 mm per month from November to April, to more than 510 mm per month from July to October.

TABLE 23. RAINFALL STATISTICS FOR MAKINA MISSION, MARAU SOUND, AND FOR KAU KAU BAY, EAST GUADALCANAL

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	year
						Makina							
1962													
total rainfall (mm)	163·6	501·1	377·4	235·5	347·7	497·3	866·9	488·4	522·7	502·9	274·3	352·0	5130·0
no. raindays	15	25	21	20	24	22	21	27	27	23	22	23	270
mean/rainday (mm)	10·7	19·8	17·8	11·7	14·5	22·6	41·1	18·0	19·3	21·8	12·4	15·2	18·8
daily maximum (mm)	21·3	88·9	62·2	68·6	95·2	156·2	307·1	55·9	116·8	103·4	50·8	74·9	—
1963													
total rainfall (mm)	174·0	122·2	316·2	175·0	443·2	241·8	691·4	1023·1	645·7	1186·2	450·8	546·6	6016·2
no. raindays	23	16	23	17	20	19	25	27	27	25	21	25	268
mean/raindays (mm)	7·4	7·6	13·7	10·2	22·1	12·7	27·4	37·8	23·9	47·2	21·3	21·8	22·4
daily maximum (mm)	24·9	32·5	62·2	58·4	158·7	46·2	125·7	175·3	113·5	168·9	115·6	101·6	—
1964													
total rainfall (mm)	273·8	152·9	329·7	353·1	278·6	330·2	271·8	336·3	389·1	344·9	354·6	167·6	3582·7
no. raindays	17	15	20	16	14	19	20	18	20	24	22	—	—
mean/rainday (mm)	16·0	10·2	16·3	21·8	19·8	17·3	13·5	18·5	19·3	14·2	16·0	16·5	—
daily maximum (mm)	64·8	38·1	55·9	114·3	33·0	38·1	83·8	88·9	69·8	50·8	50·8	—	—
1965													
total rainfall (mm)	450·1	131·8*	285·5*	258·3	725·9	659·4	597·7	557·0	543·6	651·0	262·6	384·0	5507·0
no. raindays	24	8*	19*	21	26	27	27	20	18	22	17	19	248*
mean/rainday (mm)	18·5	16·3	15·0	12·2	27·7	24·4	22·1	27·7	30·0	21·0	8·7	12·4	22·1
daily maximum (mm)	73·7	57·2	66·0	42·2	101·6	101·6	101·6	146·1	71·1	202·2	52·1	63·5	—
1962–5													
mean rainfall (mm)	290·8	258·6†	341·1†	255·3	448·8	432·0	606·8	601·2	525·3	671·3	335·5	362·5	5058·9
						Kau Kau							
mean rainfall (mm) (28 y)	288·8	263·7	278·1	276·1	381·2	520·0	484·4	456·2	489·7	442·2	332·2	228·1	4452·1
mean rainfall (mm) (4 y)	265·2	258·6	341·1	255·3	448·8	432·1	606·8	601·2	525·3	677·9	359·9	355·3	5082·8

* Daily record incomplete. † Mean for 1962–4.

Sources. Makina: Father J. C. Volkers, S.M., Roman Catholic Mission, Makina. Kau Kau: Brookfield & Hart (1966).

The maximum monthly rainfall so far recorded is 1186·2 mm in October 1963. The intensity of rainfall, measured in terms of mean rainfall per rain-day, is generally less than 12·7 mm (0·5 in.) in the drier months and more than 25·4 mm (1 in.) in the wetter ones. The highest mean daily intensity recorded in any month is 47·2 mm (1·86 in.) per day in October 1963. Falls of more than 100 mm (4 in.) per day occurred 4 times in 1962, 12 times in 1963, once in 1964, and 5 times in 1965. The maximum daily rainfall recorded was 307·3 mm (12·09 in.) on 30 July 1962, followed by 203·2 mm (8·00 in.) on 7 October 1965, the latter while the expedition was in camp at Paruru.

3·2. *Tides*

The nearest tidal station to Marau Sound is at Kakum, 100 km to the west on the north coast of Guadalcanal. Kukum has an extreme tidal range of 0·97 m, and a tidal range as follows:

average heights (m)		heights at springs near the solstices (m)	
mean higher H.W.	mean lower L.W.	mean higher H.W.	mean lower L.W.
0·67	0·18	0·91	−0·06

Source. Admiralty Chart 3413.

A Foxboro–Yoxall automatic tide-gauge was operated at Paruru Jetty, Marau Sound from 17 September to 11 October 1965, with twice-daily readings from an adjacent tide pole. Figure 93 shows the mixed tidal record, the tide being markedly semidiurnal at springs and diurnal at neaps. The smallest daily range recorded was 0·43 m, the largest 1·07 m.

4. The reefs

The sea-level reef flats of Marau Sound cover 25 km², including both the fringing reefs of the high islands and the wide flats of the barrier reef, the latter up to 2 km broad. Where the barrier reef joins the fringing reefs of the Guadalcanal mainland, the reefs are clearly slightly elevated: planed intertidal flats and dissected elevated limestones have already been described from the south coast of Guadalcanal, at Vavau Point, Purikiki, and Kopiu Bay (Stoddart 1969). In Marau Sound itself only one small outcrop of elevated reef limestone has been found, on the north side of Pelakauro Island, where a relict stack 3·7 m high stands behind the mangrove fringe.

Sea-level reef flats in Marau Sound are characteristically planed rock surfaces, drying at low water. The outer parts are mantled with coral rubble and cobbles, in places forming a discontinuous boulder ridge near the reef edge, while the inner parts are coated with a discontinuous sheet of sand bound by marine angiosperms. Sediment samples from the reef flat south of Niu Island are coarse sands with mean size 0·6 to 0·7ϕ, moderately well sorted (σ_I 0·7 to 1·0ϕ), and not markedly skewed. Erosional residuals of higher reef flats are lacking on these surfaces, except at North Island, where the residuals are probably formed of clastic beach deposits now lithified rather than of reef limestone. Most of the flats show evidence of erosional origin, however, in their smoothly polished surfaces,

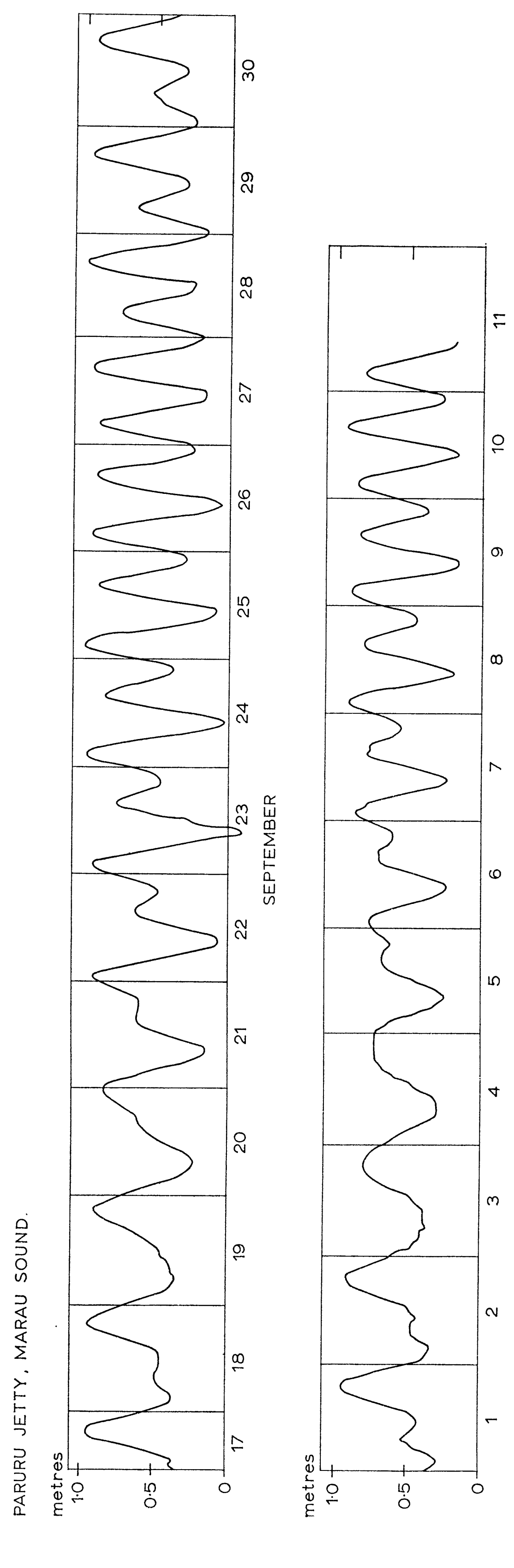

FIGURE 93. Tide curve for Paruru, Marau Sound, 17 September to 11 October 1965.

potholes or grooves. At North and Niu Islands large coral colonies up to 2 m in diameter have been bevelled by this erosion (figure 115, plate 63). It is possible that the reef flats round North and Symons Islands stand at a higher level than those of the barrier between Lauvie and East Islands, with intermediate levels between, but this suggestion could not be confirmed during the expedition.

Almost all the Marau Sound reef flats are devoid of growing coral (figure 117, plate 64): only one flourishing reef was seen, 0·3 km north-west of Paruru on the mainland, though the reef slopes support growing corals. Coral colonies on the flats are invariably dead, though unfragmented and in the position of growth, for example on Harbour Reef (figure 114, plate 63). This phenomenon, similar to the decadence reported from the Marshall Islands by Stearns (1945), is widespread in the Solomon Islands, and could be caused by either recent tectonic upheaval of the reefs, by a small eustatic fall in sea level, or by seasonal fluctuations in sea level (discussion in Stoddart 1969).

The peripheral Marau barrier reef is not continuous as a sea-level feature, but surface sectors are linked by slightly submerged reefs lacking a surface reef flat (figure 91). These submerged reefs are most extensive on the easternmost part of the barrier, and at Taunu Shoal, a reef patch 0·45 km in diameter 0·6 km east of the barrier. The shoal has a minimum depth of 3·6 m, and is covered with growing corals in groove-spur formations.

The formation of the Marau barrier reef on the submergent eastern end of Guadalcanal has been followed, therefore, by subsequent emergence to form the elevated reef terraces of the south mainland coast. Erosion of these elevated reefs has formed high intertidal flats on which the present cays stand, and residuals from the higher reefs are found at Pelakauro and possibly elsewhere. It is possible that continued tilting to the east has led to differences in height between the westerly and easterly reef flats, and has inhibited coral growth at higher levels. The recent mortality of corals may be related to these movements, or to other causes. We have no data on the absolute chronology of these events, or their relationship to Pleistocene history.

5. The cays

The cays of Marau Sound may be grouped into three types: simple sand cays, mostly vegetated; sand cays with beachrock; and cays or pseudo-cays with igneous outcrops.

5·1. *Simple sand cays*

The simplest cays of the Marau Sound reefs are ephemeral unvegetated sandbores, all less than 100 m long, either elliptical or crescentic in plan, and frequently overtopped by waves. At low water when the reef flats dry, these sandbores are revealed as well-defined accumulations of carbonate sands perched on the flats. Examples include sandbores on Harbour Reef (between Komachu and Tawaihi), on the flats between Niu and Paipai, and Round Island (figure 94; figure 116, plate 64) in Wolverine Channel. Drift-seeds of *Barringtonia* were found on the latter, which is the largest unvegetated cay (3850 m^2), and roots embedded in the sand show that it was formerly vegetated.

Vegetated sand cays without extensive beachrock development range in size from 4250 to 117 700 m^2. Cays in this class fall into two groups: smaller islands retaining much natural vegetation, and two larger islands extensively modified by man. Quinine Island (figure 95) is little more than an emergent section of a sandpit extending from Pelakauro Island in the Wilson Group. It is 90 m long, with a small vegetated core, surrounded by large *Rhizophora* and *Bruguiera* trees, and with tall *Hernandia* and a few coconuts. Berm

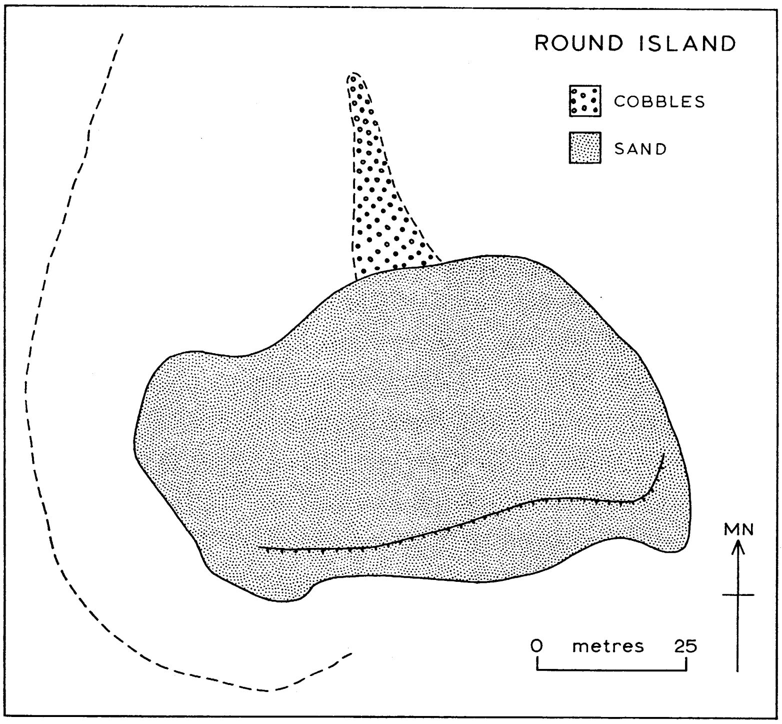

FIGURE 94. Round Island.

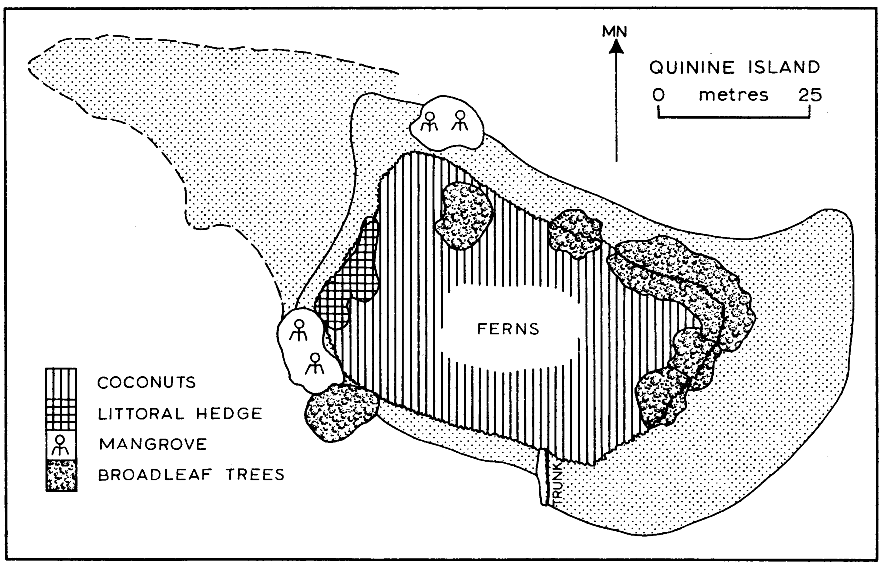

FIGURE 95. Quinine Island.

shrubs include *Scaevola* and *Sophora*. Tese Island (figure 96), on the eastern Marau barrier, is twice as large (9200 m^2, length 140 m) and more diverse. The island is almost entirely built of sand, with sublittoral cobbles, and fresh beaches are banked against previously eroded shores on its western side. The vegetation is dominated by a belt of broadleaf woodland (mainly *Hernandia sonora*, with *Allophylus timorensis*, *Morinda citrifolia* and *Celtis paniculata*) and another of tall *Casuarina*. There are a few pandans and coconuts. Berm shrubs include *Sophora*, *Tournefortia* and *Scaevola*, and on the prograding west side there is a small area of strand pioneers (*Lepturus repens*, *Euphorbia chamissonis*). Paipai Island (figure 97), in

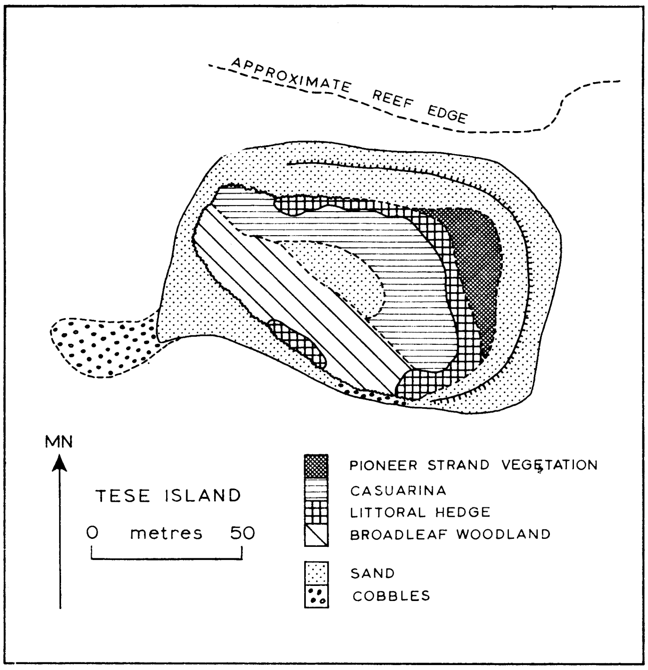

FIGURE 96. Tese Island.

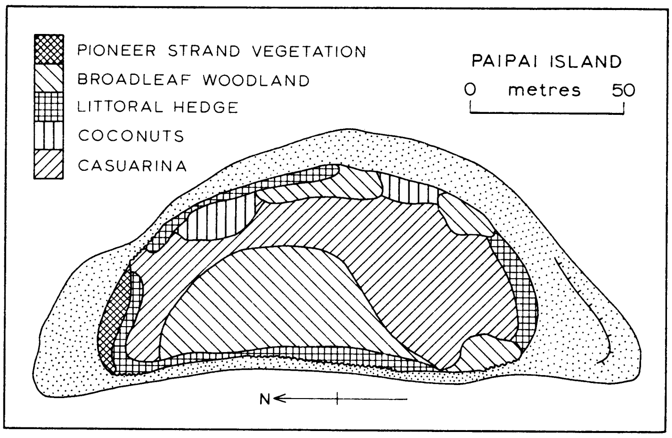

FIGURE 97. Paipai Island.

an equally protected situation, is slightly larger (area 11 800 m^2, length 180 m) and floristically more diverse. Much of the island is covered with *Casuarina*, or with a broadleaf woodland of *Hernandia*, *Cordia* and *Diospyros*. *Scaevola*, *Tournefortia* and *Sophora* form a fairly continuous littoral hedge and there are patches of coconuts and *Tacca*. *Cassytha* and *Canavalia cathartica* were noted.

Pari Island (figure 98), on one of the isolated patch reefs north of Marau Sound, is again physiographically simple, but here the broadleaf woodland is less disturbed. *Barringtonia, Calophyllum* and *Hernandia* were recorded, together with areas of coconuts, *Casuarina* and *Pandanus*; *Scaevola* is the only littoral shrub. Coconuts have grown here for about a century (*Pacific Islands Pilot* 1956, p. 348).

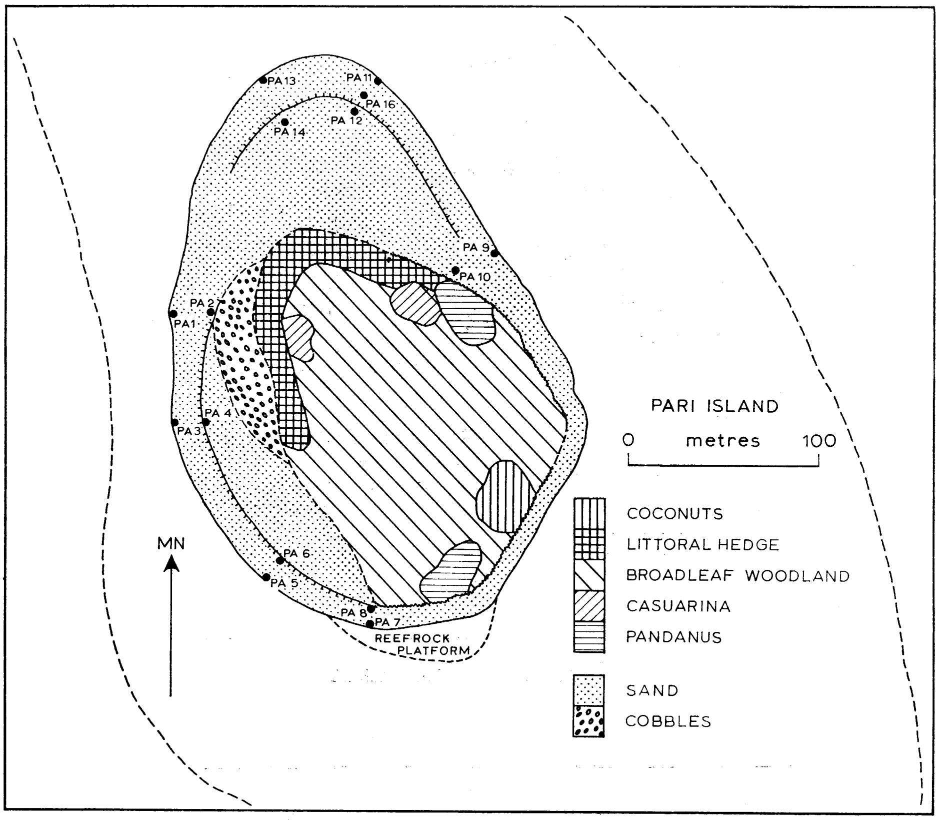

FIGURE 98. Pari Island.

Both Maraunibina (figure 99) and Niu or Pigeon Island (figure 100) have been more disturbed by man than this first group of cays. They are both larger, sandy islands, with little or no beachrock: Maraunibina with an area of 18150 m^2 is 275 m long, and Niu is 113700 m^2 in area and 640 m long. Both are largely covered with coconuts, with some *Casuarina* and *Pandanus*. Niu has, in addition, many tall littoral broadleaf trees, including *Calophyllum, Barringtonia, Cordia, Eugenia* and *Thespesia*; these are less abundant on Maraunibina. On both islands the coconuts have a rich undergrowth of shrubs, grasses, vines and herbs. On Maraunibina, these include *Wedelia biflora, Premna obtusifolia, Pipturus argenteus, Morinda citrifolia*, species of *Ficus* and *Glochidion, Ipomoea tuba, Euphorbia hirta, E. chamissonis*, and *Sporobolus indicus*. The arrowroot *Tacca* is also found under the coconuts. Niu, which is permanently inhabited, has fewer shrubs and small trees, and more herbs, grasses and weeds, including *Sida acuta, Hemigraphis repens, Ageratum conyzoides, Polygala paniculata, Vernonia cinerea*, and such introduced cultivated and decorative plants as *Terminalia catappa* and *Carica papaya* among the trees, *Hibiscus* sp., *Tagetes patula, Pseuderanthemum* cf. *bicolor, Ocimum sanctum* and *Desmodium canum*. The village on Niu has an

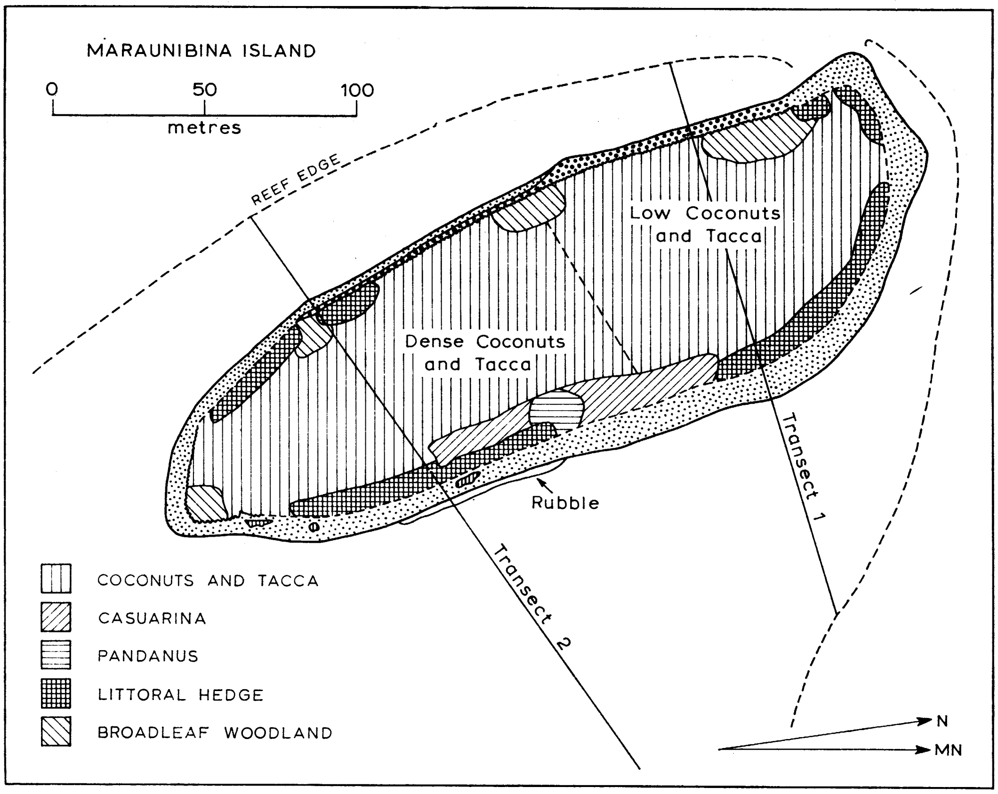

FIGURE 99. Maraunibina Island.

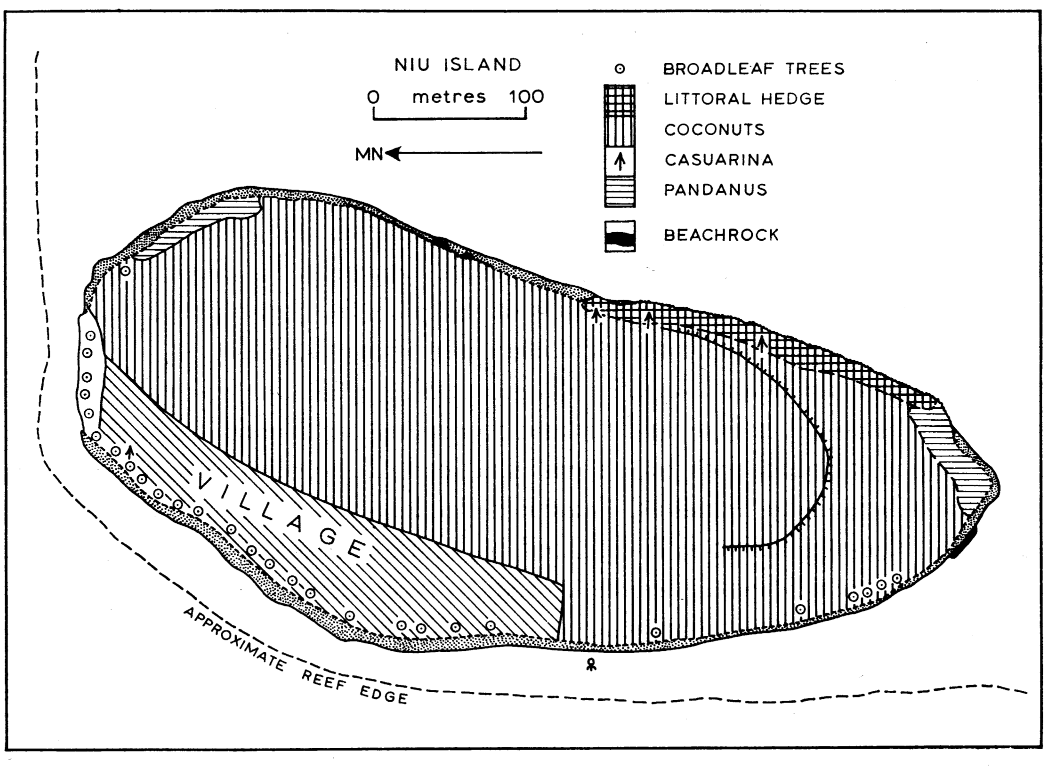

FIGURE 100. Niu or Pigeon Island

enormous *Ficus* with trunk about 27 m in diameter which towers above the rest of the island vegetation canopy. Both Niu and Maraunibina have the ferns *Polypodium scolopendria* and *Nephrolepsis hirsutula*, and the latter has in addition *Davallia solida*. Both islands have some orchids and other parasites. Niu alone has a solitary mangrove (*Rhizophora*).

5·2. *Sand cays with beachrock*

Most of the larger sand cays of Marau Sound are surrounded by wide expanses of beachrock, indicating recent migration of cay shorelines. These larger islands also in general have less disturbed vegetation than either the small simple sand cays or the larger islands of Maraunibina and Niu. Five cays of the Marau barrier reef are discussed first, and then two cays on isolated reef patches north of the barrier.

Lauvie Island (figure 101), southermost of the Marau Cays, is a narrow island 380 m long with an area of 29200 m^2. Seaward-dipping beachrock outcrops extensively on its western side, up to 55 m offshore, indicating migration of the cay away from Southeast Entrance (figure 118, plate 65). Small beachrock exposures on the north and east shores indicate slight retreat. The whole island is sandy, with a flat surface 1·8 m above approximate mean sea level. There is an intermittent littoral hedge of *Tournefortia*, *Scaevola* and *Wedelia biflora*, with clumps of *Pandanus* and some coconuts; but most of the island is covered by a dense broadleaf woodland with little undergrowth. Identified constituents of this woodland are *Soulamea amara*, *Pongamia pinnata*, *Cordia subcordata*, *Guettarda speciosa*, *Hernandia sonora*, and species of *Barringtonia*, *Polyscias* and *Pouteria*. At the south end of the cay the broadleaf woodland is replaced by a tall stand of *Casuarina*. There is some *Tacca*.

Kosha or Kotsa Island (figure 102), farther north on the same reef flat, also shows lagoonward migration in the relict beachrock on its south-west and east shores. This retreat has been less than at Lauvie, and the superimposed beachrocks, overlain by fresh sand, at the south point indicate complex recent fluctuations. At the time of survey, the whole east and north shores were cliffed and eroding and a fresh sandspit was building north-westwards. The cay is 460 m long, with an area of 59800 m^2. The area of broadleaf woodland, with *Cordia* and *Barringtonia*, is here much reduced, and most of the cay is covered with coconut or *Pandanus* thicket, with some *Casuarina*. *Tacca* is again found under the coconuts; and the littoral hedge consists of *Tournefortia*, *Scaevola* and *Sophora*. Where the spit is building out there is pioneer colonization by *Ipomoea tuba*.

Tarvarau or Southeast Island (figure 103) is remarkably similar to Lauvie, 275 m long, with an area of 15200 m^2, it is a sandy island retreating north-westwards away from the open sea leaving relict beachrock on its east and especially south-west sides (figure 119, plate 65). Apart from some *Casuarina*, *Cocos* and *Pandanus*, and the littoral shrubs *Scaevola* and *Tournefortia*, the vegetation is dominated by broadlead woodland. Species recorded include *Hernandia sonora*, *Mammea odorata*, *Allophylus timorensis*, *Guettarda speciosa*, species of *Pouteria*, and shrubby *Premna obtusifolia*. A grass (*Lepturus*?), a *Euphorbia*, and *Cassytha* colonize more open areas. The cay is prograding northwards.

Horohato or Square Island (figure 104) is a larger cay, 300 to 350 m in diameter and 44300 m^2 in area. Massive beachrock along the north-east and south shores indicates a general lagoonward migration (figure 120, plate 66); but reburial of some beachrock by

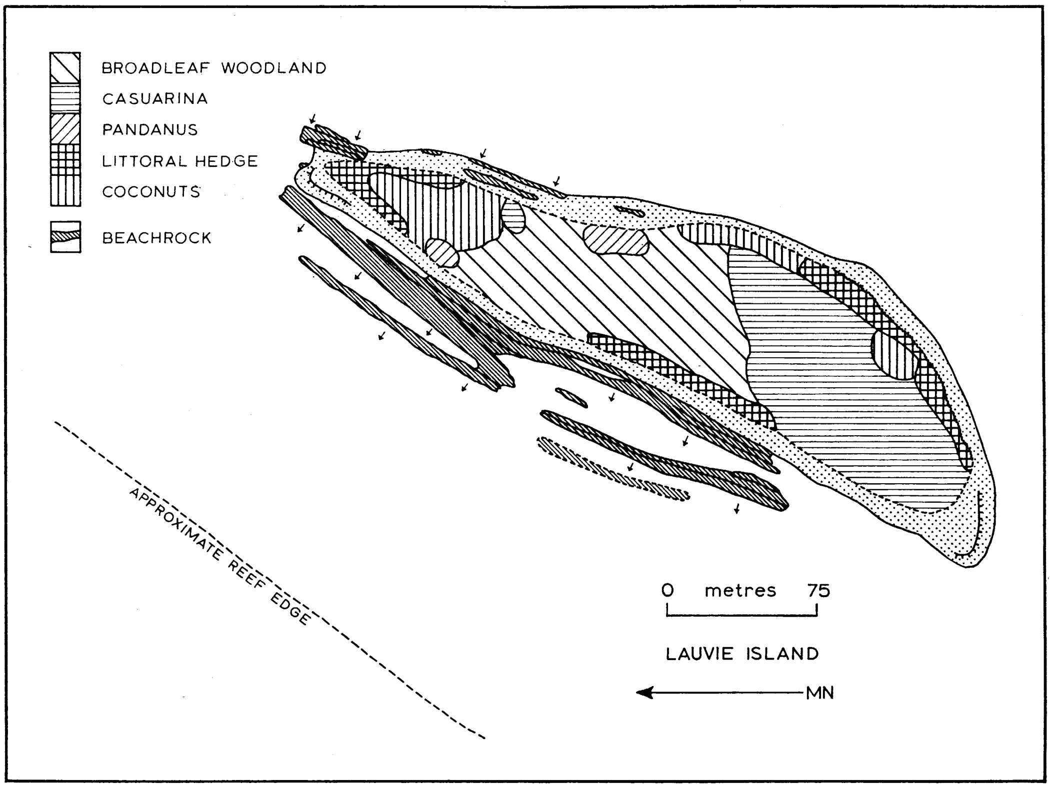

FIGURE 101. Lauvie Island.

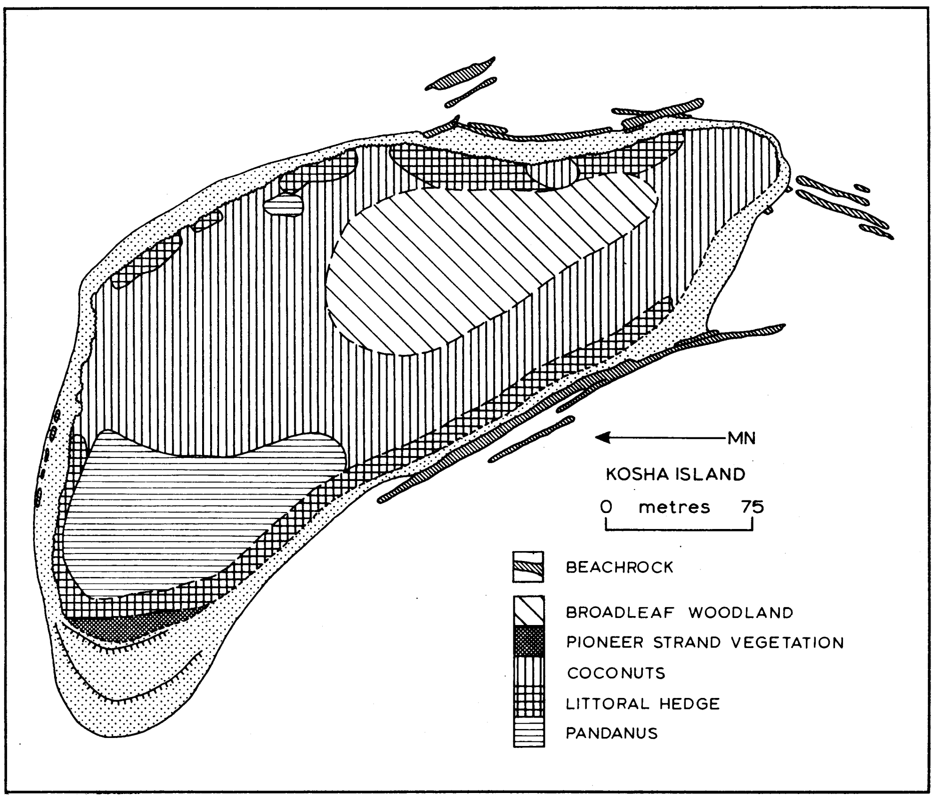

FIGURE 102. Kosha or Kotsa Island.

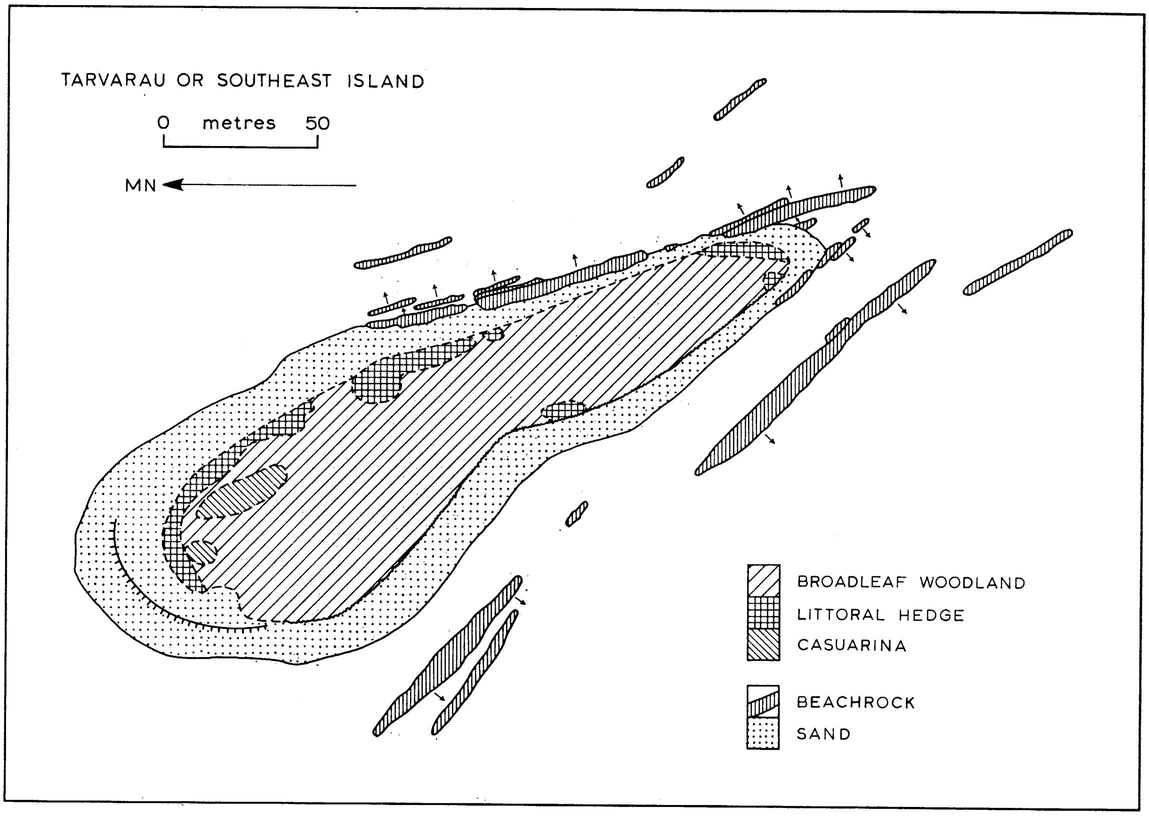

FIGURE 103. Tarvarau or Southeast Island.

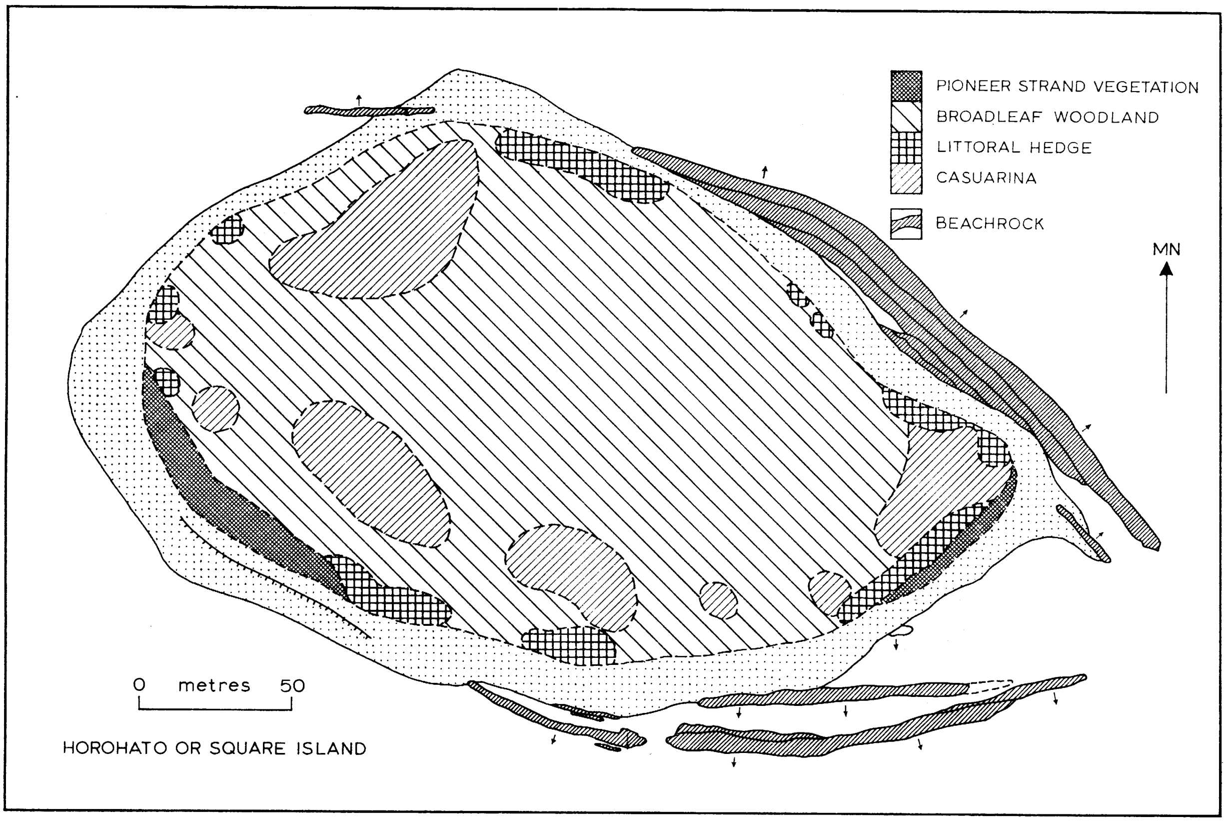

FIGURE 104. Horohato or Square Island.

modern beach sands shows that this is an irregular movement. The island is sandy, with wide beaches, colonized in the west and at the east point by the pioneers *Vigna marina* and *Euphorbia chamissonis*. *Tournefortia*, *Scaevola* and *Sophora* constitute the berm hedge, together with *Wedelia* and *Celtis*. Most of the surface is covered with dense broadleaf woodland, with clumps of *Casuarina*. Woodland constituents identified are *Calophyllum inophyllum*, *Cordia subcordata*, *Soulamea amara*, *Hernandia sonora*, *Pouteria* cf. *obovata*, *Ochrosia oppositifolia*. Two ferns are recorded: *Polypodium scolopendria* (also on Niu and Maraunibina) and *Asplenium nidus*. *Cassytha* is also found.

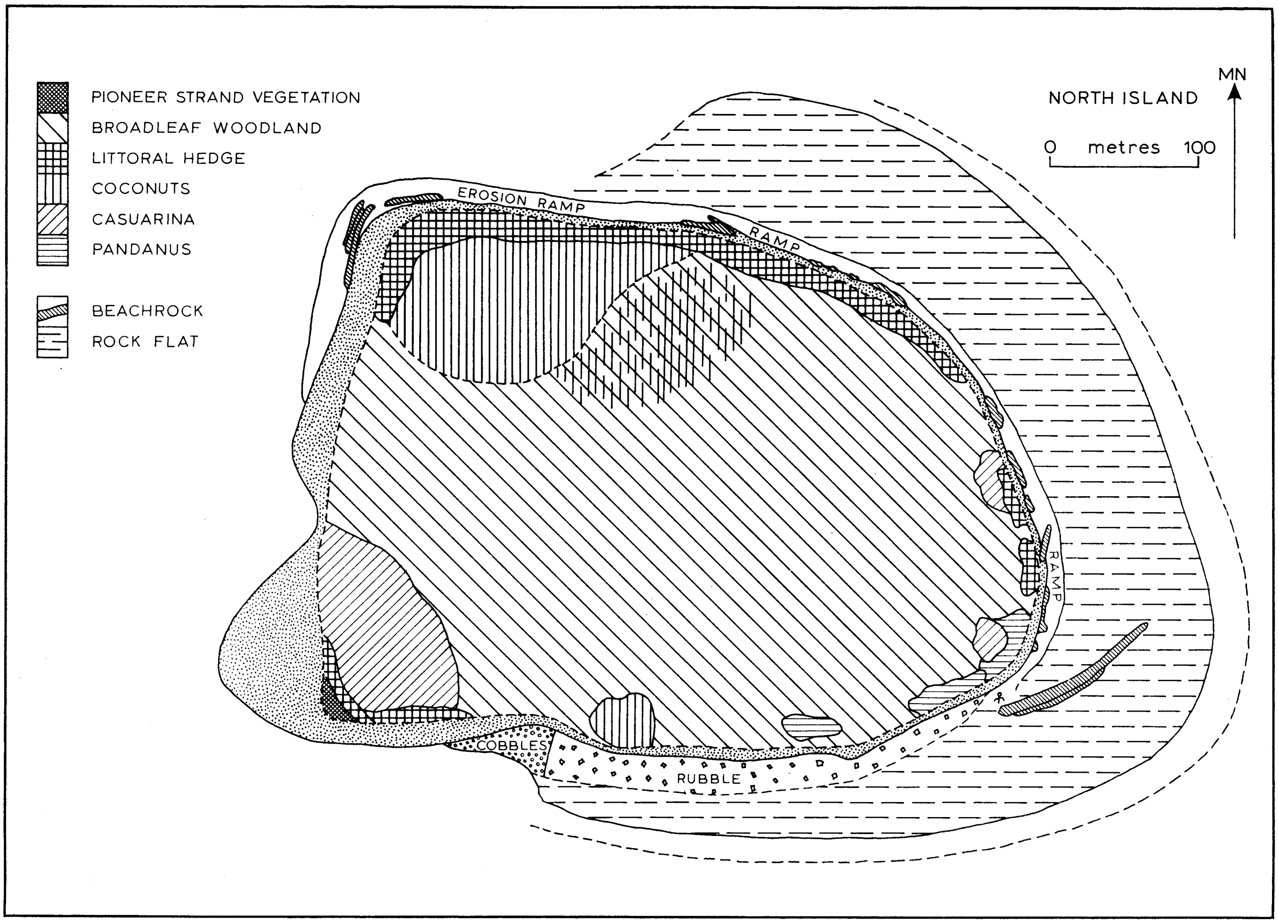

FIGURE 105. North Island.

Symons and North Islands, to the north of Marau Sound, differ from the islands just described in their smaller size and the higher levels of the reef flats on which they stand. North Island (figure 105), 360–500 m in diameter and 157100 m^2 in area, stands on a drying rock platform with degraded beachrock outliers (figure 121, plate 66); r)und the shores the rock platform forms an erosion ramp, the surface of which transects and bevels old coral colonies. The platform has a mean width of 90 m on the south side of the cay. Beachrock outcrops on the windward beaches, which are slightly retreating, and the cay is growing westwards by the addition of fresh sand. There is a little pioneer *Euphorbia* on the prograding beaches, but elsewhere a littoral hedge of *Scaevola*, *Tournefortia* and *Sophora*.

Apart from areas of *Casuarina*, *Pandanus* and coconuts, the whole island is covered with dense broadleaf woodland with much *Hernandia sonora*. The composition of this woodland has not been studied in detail.

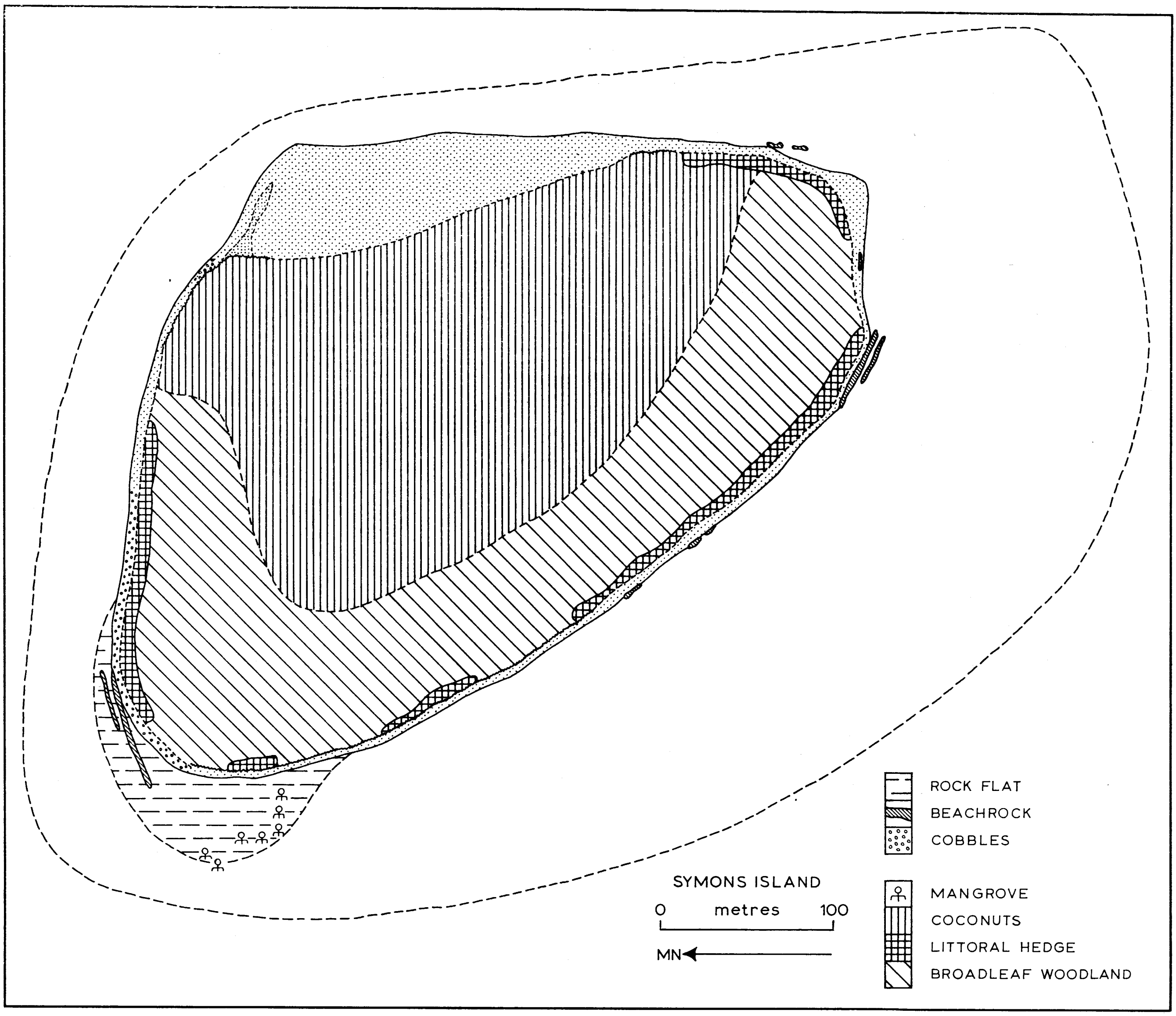

FIGURE 106. Symons Island.

Symons Island (figure 106), to the west, is similar though smaller (500 m long, area 111 400 m^2), and the high rock flat is less extensive. Beachrock on the windward side indicates only slight beach migration. The island is built of sand except for a cobble beach along the north shore, where deep water approaches close to the beach. *Scaevola*, *Tournefortia* and *Sophora* form the littoral hedge. The southernmost half of the cay is still under broadleaf woodland (*Hernandia*, *Barringtonia* and many other species), but the north has been cleared for coconuts, and the island has clearly at one time been inhabited. There is some *Casuarina*, and also *Pandanus*. Mangroves are represented by seedlings and bushes of *Rhizophora* at the west point.

5·3. *Cays with igneous outcrops*

Three islands were mapped which may be classed as pseudo-cays, or sand cays with outcrops of non-carbonate rocks. In each case the outcrops are so small that the islands can readily be distinguished from the high islands with sand tails described by Steers (1937) from the Great Barrier Reef and by Guilcher (1958) from Madagascar. The islands are Keura and Pelakauro (Somayu) in the Wilson Group, in the centre of Marau Sound

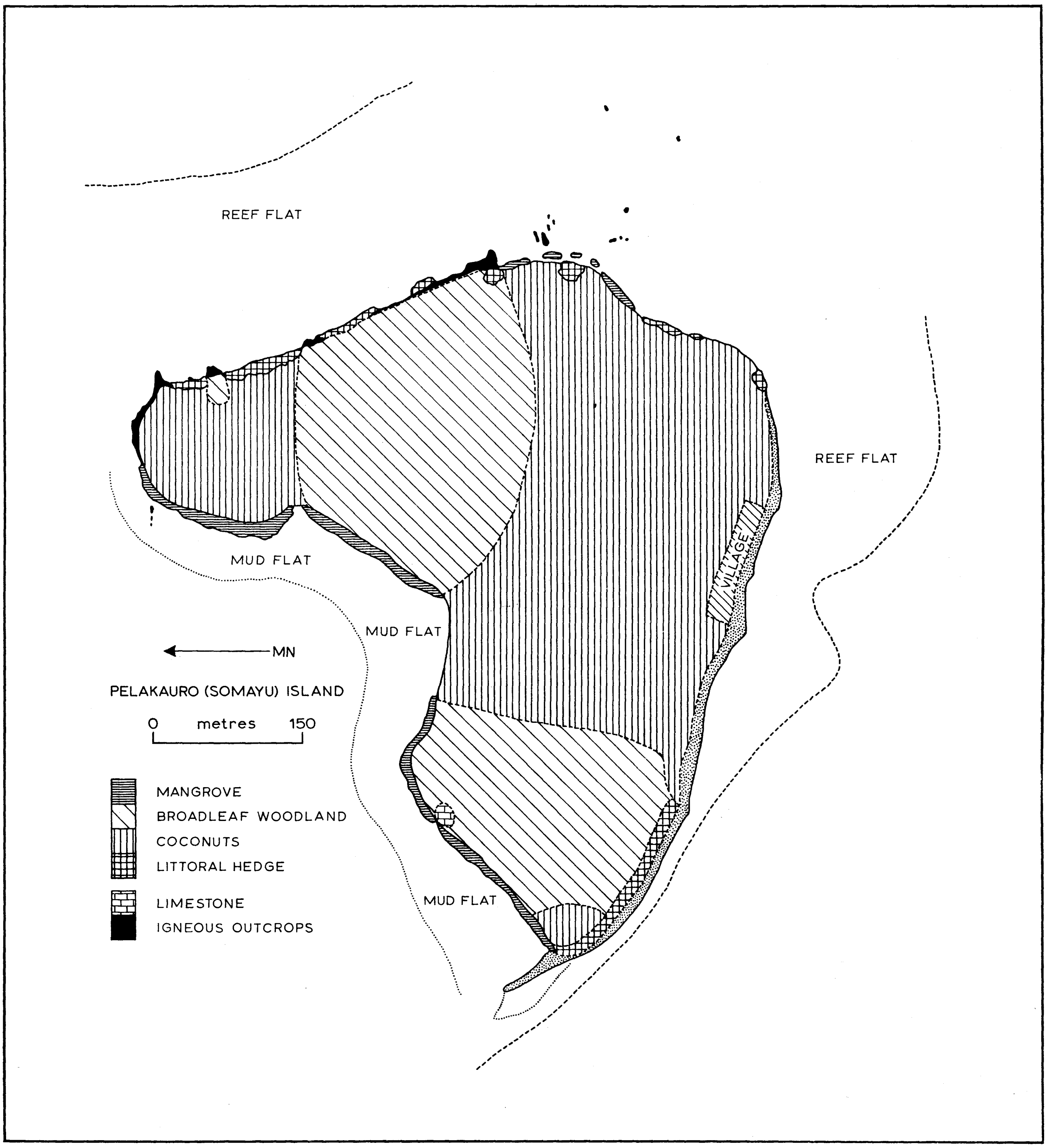

FIGURE 107. Pelakauro Island.

between the high islands of Beagle and Malapa, and Horohato or East Island on the wide fringing reef to the east of Malapa. It was not possible to visit Cimiruka Island, to the south-west of Malapa, but this may be another pseudo-cay.

Pelakauro (figure 107), in the Wilsons, has an area of 249 700 m^2 and is the largest island considered in this study. The south shore is sandy, and a sand surface extends north of the village to the northern shore, which is muddy and lined by mangroves (*Rhizophora*, *Bruguiera*). The sand area is covered with coconuts. To the east and north-east, however,

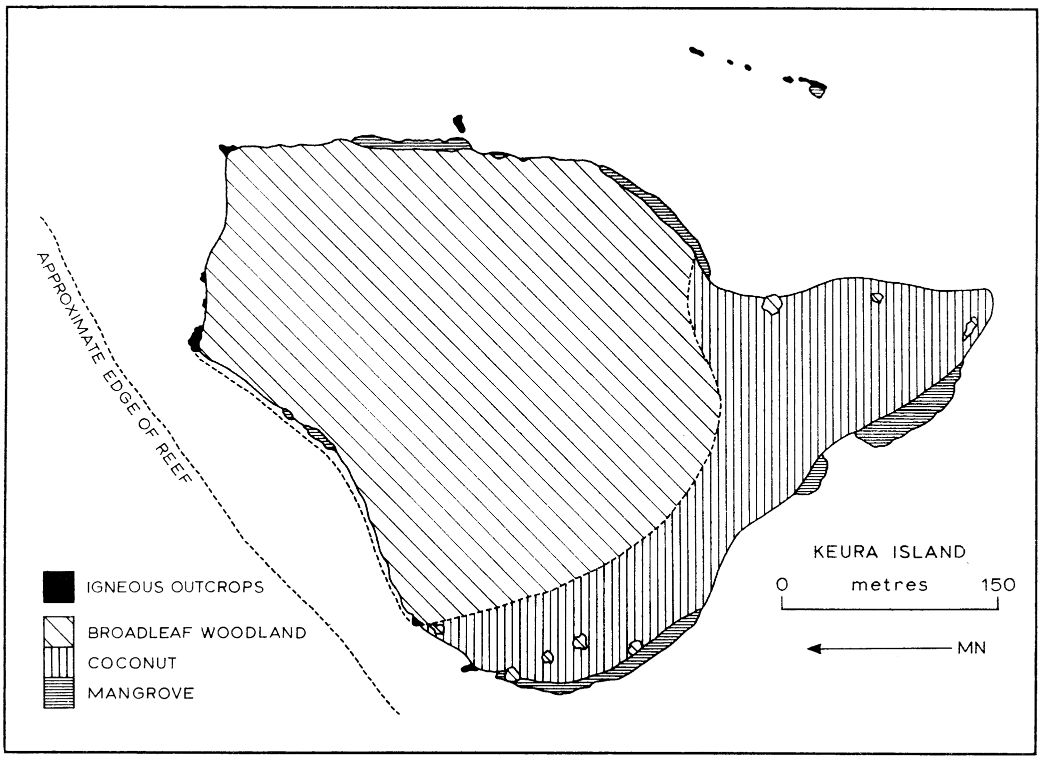

FIGURE 108. Keura Island.

nubbins of igneous rock outcrop to a height of a few feet on the reef flat and beach, and inland these are covered by dense woodland (figure 122, plate 67). The exact extent and height of these outcrops is not known. At the west end there is another area of dense woodland, which may conceal more igneous outcrops. Near the north shore there is a small outcrop of elevated reef limestone 4·5 m high, tidally notched and hidden by mangroves (figure 123, plate 67). Little is known of the vegetation of Pelakauro, which is certainly more complex than that of simple sand cays. In addition to the coconuts and mangroves, there are tall *Hernandia* and *Calophyllum*, *Casuarina* and *Pandanus*, and along the shore *Scaevola* and *Sophora* (but not *Tournefortia*). The presence of a village, as on Niu, has led to many introductions.

Keura Island (figure 108) to the north has an area of 111 700 m^2. The northern part of the island is under broadleaf woodland, with igneous outcrops on a steep shore. The extent and height of the outcrops within the woodland is unknown. The south and west parts of the cay are sandy, covered with coconuts and scattered broadleaf trees, and fringed by mangroves (*Rhizophora*, *Bruguiera*). The ground cover under the coconuts consists of *Euphorbia*, *Canavalia*, ferns, grasses, and *Tacca leontopetaloides*; with some *Scaevola* and *Sophora* (again no *Tournefortia*) round the shores. *Barringtonia* and *Calophyllum* are prominent nearshore trees.

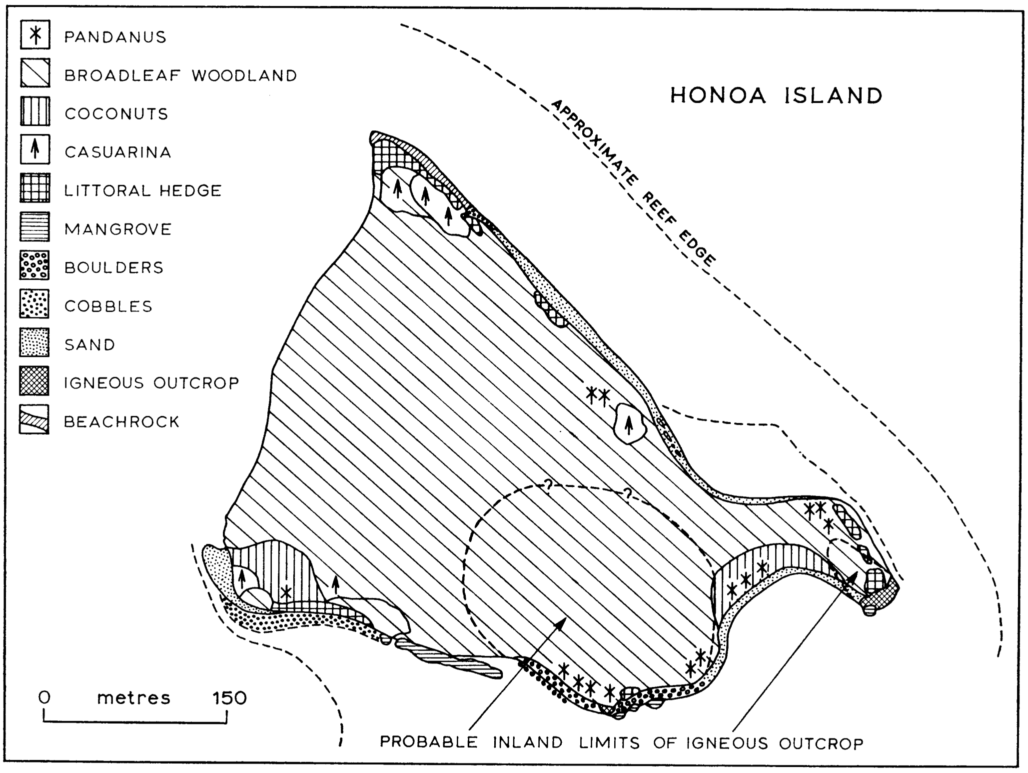

FIGURE 109. Honoa or East Island.

Honoa or East Island (figure 109) lies on the broad fringing reef east of Malapa. It has two main igneous outcrops, both on the south coast. The larger forms hillocks up to 15 m high, with a shoreline of large igneous boulders fringed by mangroves. The precise inland extent of these residuals is not known. The rest of the island is built of carbonate sands and gravels. The cay has sides about 570 m long, and has an area of 129800 m^2; the eastern beach is sandy, 18 to 27 m wide and 1·2 to 1·5 m high. Honoa is covered with dense broadleaf woodland, with *Barringtonia*, *Hernandia*, *Cordia* and many other trees. There are small patches of coconuts on the south shore, and scattered small areas of *Casuarina*. Two species of *Pandanus* are present. The broadleaf woodland extends down to the top of the beach round most of the island, and on the west shore tall *Barringtonia* and *Hernandia* lean out over the sea. There are some small patches of *Scaevola* and *Tournefortia*, with *Pemphis acidula* at the rocky south-east point. *Sporobolus indicus* was collected. The south shore mangroves are entirely *Rhizophora*. The island is not inhabited, but is used as a burial place by neighbouring islanders: there are cairns and skulls exhibited at the south-east point.

6. The vegetation of the cays

Field mapping of the Marau cays suggests a major distinction between the vegetation of islands much disturbed by man, dominated by coconuts and *Casuarina*, and the less disturbed islands (such as East, Keura, North, Horohato and Tarvarau) which are still largely covered with broadleaf woodland. In both cases the littoral vegetation (beach crest and strand pioneer) is the same; but the disturbed islands have a much more diverse vegetation of grasses, herbs and weeds. Of the floras of the Solomons, that by Walker (1948) is more useful than that by Whitmore (1966), for the latter keys only the larger trees. According to Whitmore, the forest flora of Melanesia is poor by comparison with that of Malesia, and this poverty must be evident on the Guadalcanal mainland and on the larger igneous islands of Beagle, Komachu and Malapa in Marau Sound. While Melanesian elements are certainly found on the cays, particularly on those with small igneous outcrops, the cay flora as a whole is more usefully viewed in relation to the Indo-Pacific 'strand flora' rather than to the Melanesian forest flora.

[redacted]

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FIGURE 112. Marau Sound from the air: Round Island in the foreground, looking south across the northern end of Beagle Island.

FIGURE 113. Marau Sound from the air: the outer barrier, looking south, with Honoa and Horohato Islands on the left and the plunging spurs of Malapa Island on the right.

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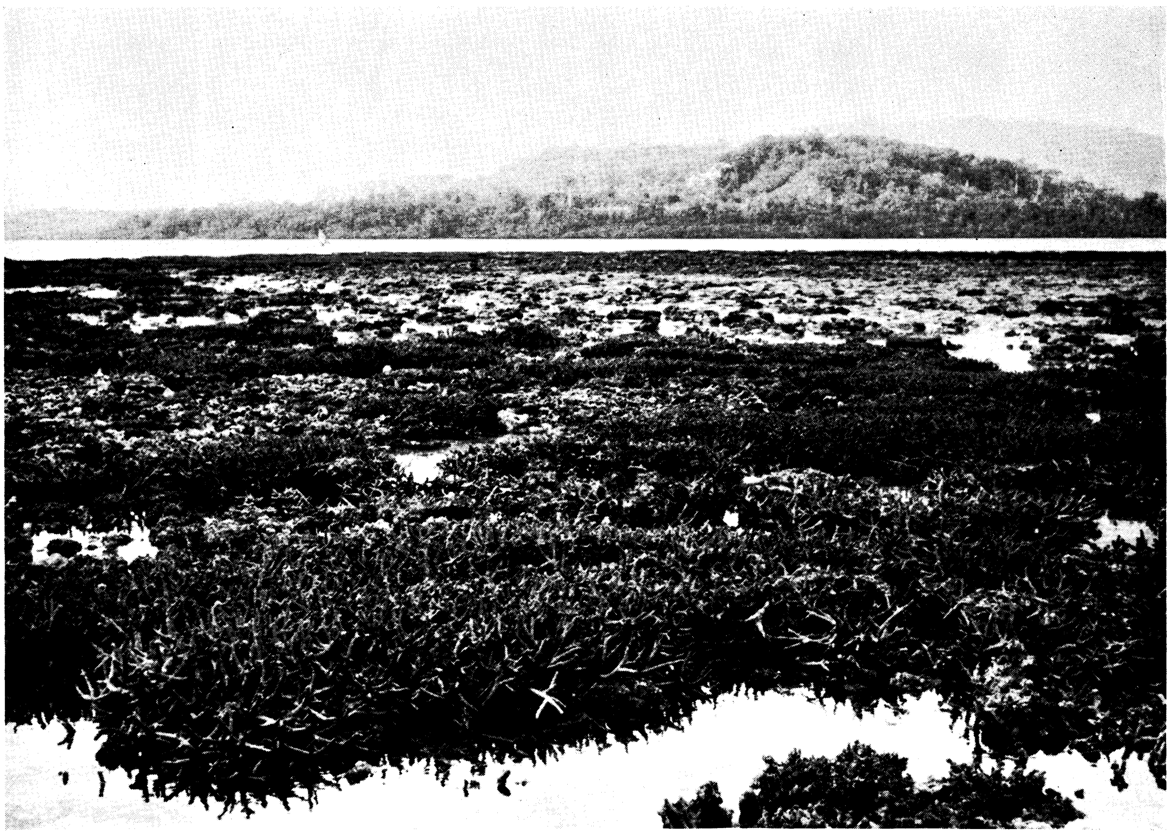
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FIGURE 114. Thickets of dead *Acropora* exposed on the drying reef-flat surface of Harbour Reef.
FIGURE 115. Meandrine corals bevelled by erosion of the reef-flat surface at North Island.

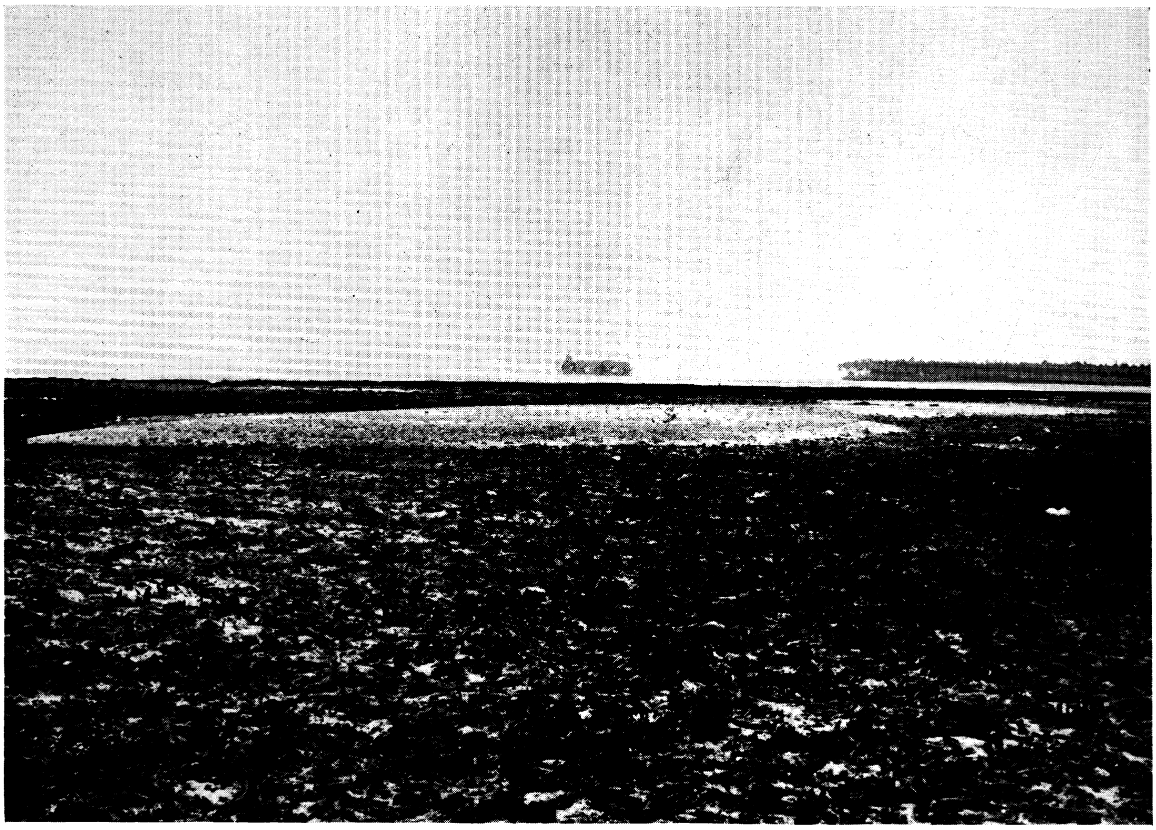

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FIGURE 116. Simple unvegetated sand cay: Round Island at low spring tide.

FIGURE 117. Exposed reef flat with a narrow sandy beach on the mainland coast at Paruru; Paruru jetty tidal station in the background.

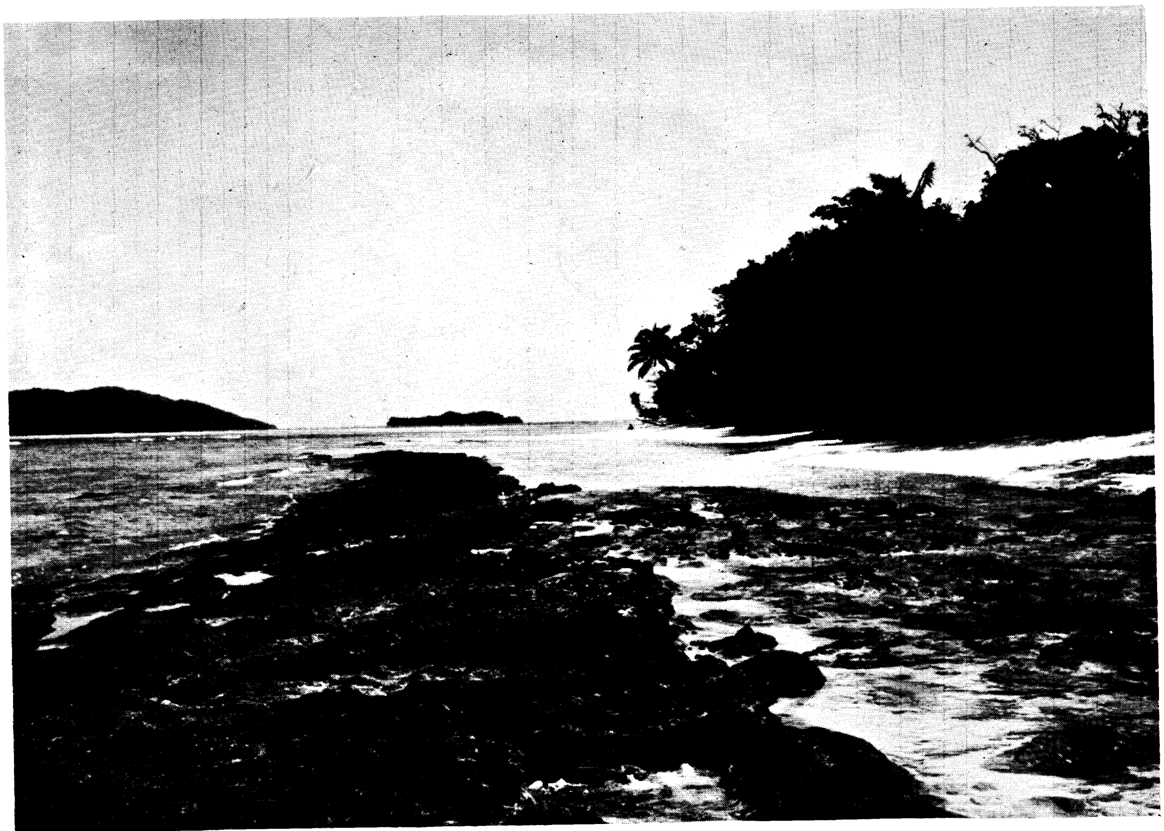

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FIGURE 118. Beachrock on the west coast of Lauvie Island.

FIGURE 119. Beachrock at Tarvarau Island: note the absence of strand vegetation at the top of the beaches.

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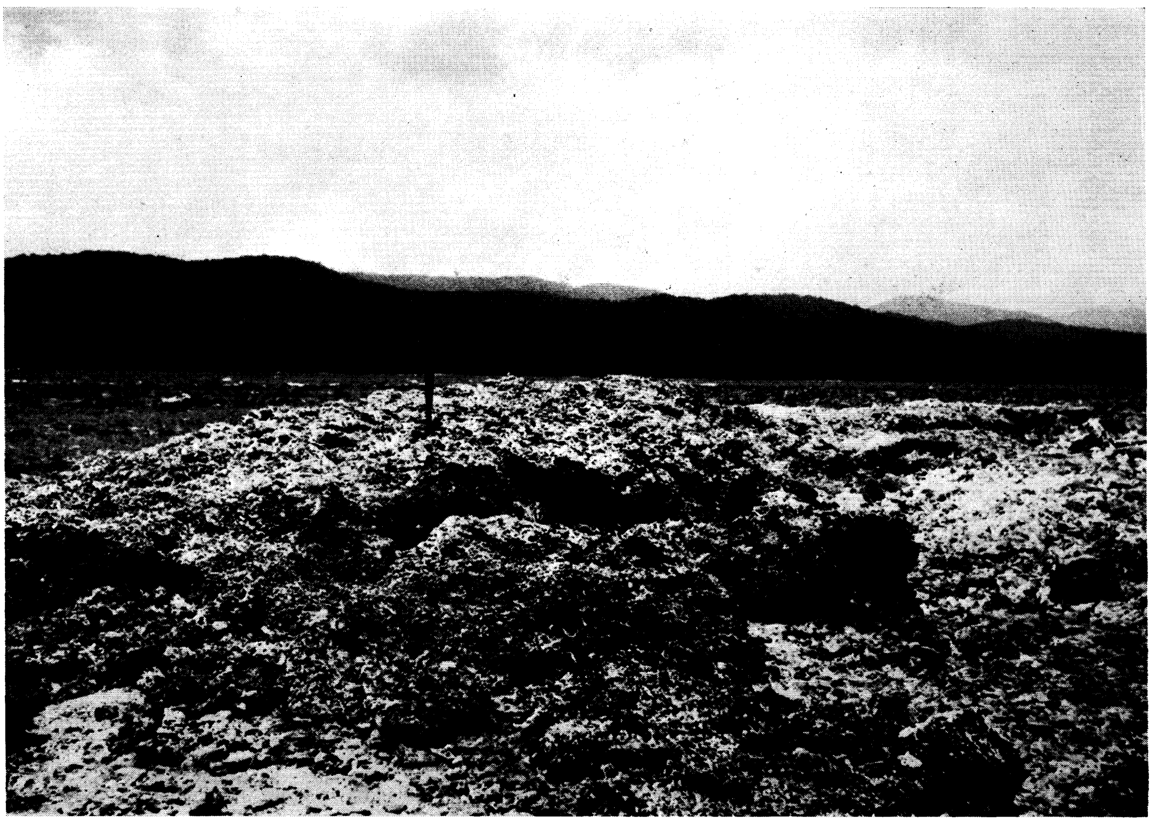

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FIGURE 120. Wide beachrock pavements at Horohato Island.

FIGURE 121. High-standing beachrock remnants on the reef flat at North Island.

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FIGURE 122. Basalt outcrops on the inner reef flat at Pelakauro Island.

FIGURE 123. Raised reef limestone on the north coast of Pelakauro Island.

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FIGURE 124. Pioneer strand vegetation on a prograding sandspit at Paipai Island.
FIGURE 125. Littoral hedge of *Tournefortia argentea* and *Pandanus* at Lauvie Island.

6·3. *Broadleaf woodland*

The broadleaf woodland is complex and inadequately known. The most common littoral trees are widespread species: *Barringtonia asiatica*, *Calophyllum inophyllum*, *Hernandia sonora* and *Cordia subcordata*; but there are at least two dozen other species comprising the woodland, some of which have not been identified. They include *Ochrosia oppositifolia*, species of *Pouteria*, *Diospyros* and *Eugenia*, *Allophylus timorensis*, *Pipturus argenteus*, *Premna obtusifolia*, *Pongamia pinnata*, *Celtis paniculata*, *Guettarda speciosa*, *Morinda citrifolia*, *Mammea odorata*, *Soulamea amara*, *Thespesia populnea*, and species of *Ficus*. These form a canopy at heights of up to 18 m, with a damp gloomy interior with little ground cover. Epiphytes such as *Dendrobium* and *Hoya* are common, and ferns are found on several islands (*Nephrolepis hirsutula*, *Davallia solida*, *Polypodium scolopendrium*, *Asplenium nidus*, and a sight record of *Acrostichum aureum*). No attempt was made to collect in the broadleaf woodland of the igneous outcrops, which is undoubtedly more complex than that of the simple cays.

6·4. *Mangrove*

Mangrove woodland fringes large parts of the mainland coast of Marau Sound, and also parts of the coasts of high islands (figure 91). It is only extensive on those cays with igneous outcrops, especially Pelakauro, Keura and East; scattered mature trees are also found on Symons and Quinine, and seedlings on Niu. Their absence on the simple cays of the peripheral reefs may be ascribed to the unstable substrate, retreating beaches, and high exposure. Species of *Rhizophora*, *Avicennia* and *Bruguiera* are present, the first being most widespread.

6·5. Casuarina *woodland*

Casuarina is common on North, Horohato, Tarvarau, Lauvie, Paipai and Tese Islands, and is present on 13 of the 15 vegetated islands mapped. It generally forms pure stands with no undergrowth: where beaches are retreating, it is susceptible to undermining, and it also seems liable to hurricane damage. The status of *Casuarina* woodland is uncertain, but in Marau it may be a natural community dispersed by natural means. Juvenile *Casuarina* are common in pioneer situations.

6·6. *Coconuts*

Coconut plantations form the dominant vegetation type on Maraunibina, Niu, Pelakauro, Symons, Kosha and Quinine. They are also important on Keura and North Islands, and trees are present in small numbers on Tarvarau, Horohato, Lauvie, Pari, Paipai and Tese. They have not been recorded from Horohato. According to the *Pacific Islands Pilot* (1956, pp. 345, 348), in which the information dates largely from the later nineteenth century, coconuts were present nearly 100 years ago on East, North and Symons Islands. Only on Niu and some of the larger part-igneous islands are coconuts grown under plantation conditions. On Maraunibina, which is more typical, the trees form a dense thicket with much secondary vegetation. There are large actively managed plantations on the adjacent mainland, at Paruru and Makina.

6·7. *Ground cover under coconuts*

Areas cleared for coconuts or habitation provide the only areas of extensive ground vegetation (grass and herb layers) on the cays; these areas include many introduced weeds. Collections at Maraunibina and Niu in this habitat include the following species:

rise gently inland from the berm. Sections were cut and profiles surveyed across Maranuibina and Lauvie Islands (figure 110): at Maraunibina the surface rises inland from a berm elevation of 2 m to a maximum height of 2·9 m, but at Lauvie the surface is flat with a constant height of 2·1 m. There is no marked surface topography on the cays, except for low ridges on Niu and some other islands which may represent old beach ridges. There are no central depressions or marshy areas of the kind described in other regions. No dunes are found on the cays or the adjacent mainland.

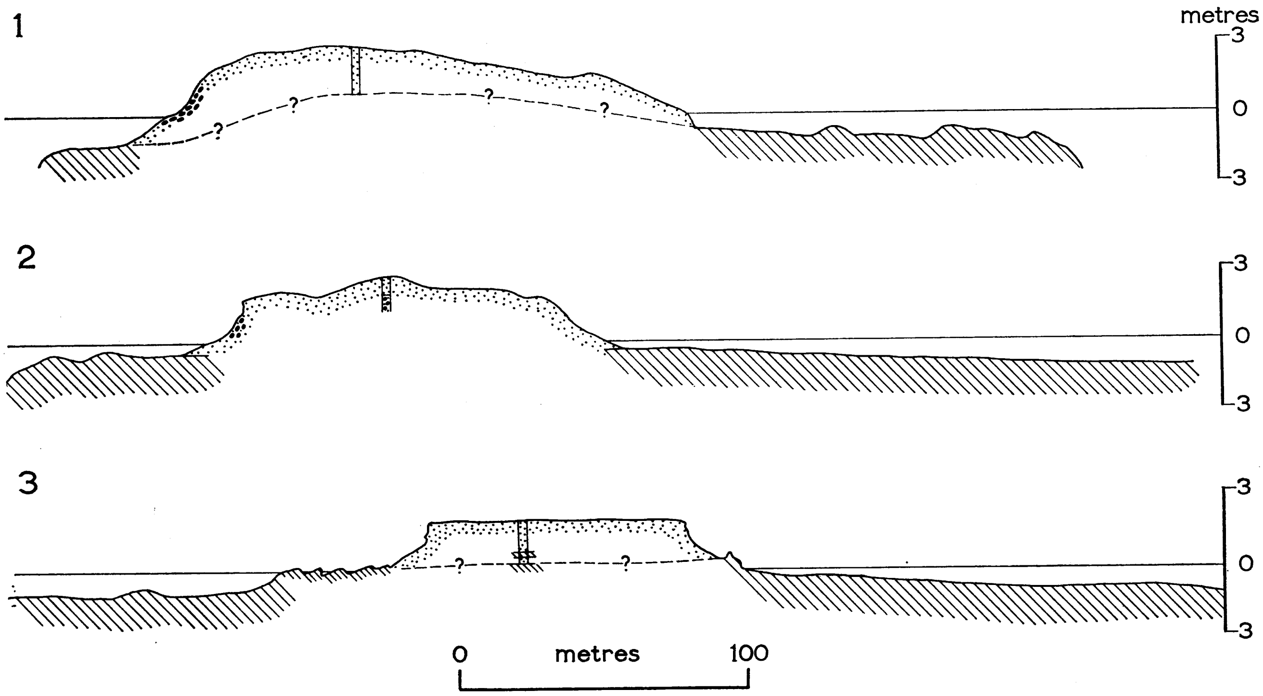

FIGURE 110. Profiles of Maraunibina Island (1 and 2) and Lauvie Island (3).
For location see figures 99 and 101.

Beaches average 5 to 10 m in width, reaching up to 20 m in exceptional cases. They are almost entirely sandy, except where close to deep water, and are often cliffed and topped by vertical steps 0·3 to 0·6 m high formed of coconut and other roots from which the sand has been flushed. Such clifflets partly buried by fresh sand indicate recurrent erosion and deposition which may be seasonal. Sandspits are found on many islands at their leeward end, aggradation thus being concurrent with windward erosion. Beach ridges are weakly developed on these sandy and often eroding shores, and none of the cays have high shingle ridges on their windward sides of the kind characteristic of British Honduran and Indo-Pacific reef islands. Such ridges are absent not only from the protected cays of the inner reef flats, but also from the cays of the barrier reef itself and of the isolated reef patches to the north. The Marau cays thus lack the diversity of form of cays found in other regions: they correspond to the Type II cays (vegetated sand cays) of the Caribbean reefs described by Stoddart (1965, p. 135).

Beach sediments were collected at Horohato, Tarvarau, Lauvie, Symons and Pari Islands for mechanical analysis, and the following parameters were calculated (Folk 1964) from the cumulative frequency curves: median size (ϕMd), mean size (ϕMz), sorting (σ_1), skewness (Sk_I), and kurtosis (K_G). Median size of these beach sands (figure 111) ranges from $-2{\cdot}82\phi$ to $+1{\cdot}86\phi$ (pebbles through to medium sand), and mean size from $-2{\cdot}91$ to $+1{\cdot}86\phi$. Most of the sediments cluster in the range 0 to $-0{\cdot}5\phi$ (coarse sand) with several extending to $+1{\cdot}5\phi$ (coarse and medium sand). Sorting is often less good than expected for carbonate beach sands, ranging from 0·3 to more than $1{\cdot}0\phi$. Most of the beach sediments have sorting values of 0·35 to 0·7 (well to moderately well sorted in Folk's terminology) or 0·8 to 0·9 (moderately sorted). The poorest sorted sediments are bimodal, consisting of medium or coarse sands with included gravel or pebble-sized coral fragments. Most of the beach sediments are symmetrical or are slightly negatively skewed, i.e. with excess coarse material (Sk_I 0 to $-0{\cdot}5$), and are mesokurtic or leptokurtic (K_G 0·9 to 1·5). No analyses of organic constituents of the grains have been made, but inspection suggests that coral, mollusc and algal (*Halimeda*) skeletal fragments are the main constituents. Foraminiferal tests are not an important component of the beach sands.

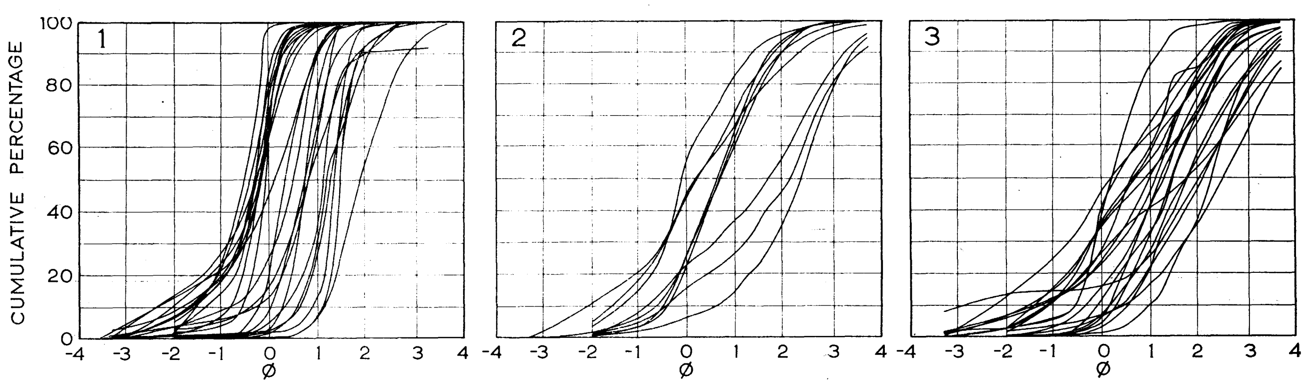

FIGURE 111. Cumulative frequency curves for beach sediments, Marau Sound cays (*a*) beach samples; (*b*) reef-flat and slope samples; (*c*) channel floor samples.

Because of the evidence of recent emergence of the reef flats, it was important to determine whether the cays are located on high-standing residuals of old reef, or whether they are simply accumulations of clastic reef debris located in response to wave energy conditions. Two test pits were dug on Maraunibina Island, no. 1 to a depth of 1·85 m and no. 2 to a depth of 1·42 m. The upper 13 cm in no. 1 consisted of dark brown humic sand, and colouring of the sand by humus extends to a depth of 0·53 m. The floor of this pit lies 0·85 m above approximate mean sea level (figure 110) and consists of well-cemented sandstone: the cementation is probably a water-table phenomenon but could be elevated reef-flat. The second pit has 20 cm of dark brown humic soil, with brown coloration extending down 0·51 m from the surface. The upper 0·73 m consists of sand, and the lower 0·68 m of coral and shell cobbles and pebbles with sand. This material was difficult to excavate and its base was not seen. The bottom of this pit was 1·2 m above approximate mean sea level.

A third pit was dug in the centre of Lauvie Island, to a depth of 1·7 m. The top 20 cm consisted of litter and humus, followed by 20 cm of dark sandy soil with roots. Brown discoloration extended 0·58 m from the surface. Between 0·58 and 1·3 m the material is sand;

the lower 0·46 m consists of a layer of lithified carbonate sands 20 cm thick, overlying a zone of lightly aggregated sand. The floor of the pit is a rock pavement at approximately mean sea level, which may be the subjacent reef flat.

Apart from variations in sediment size and the presence of lithified horizons, no sedimentary structures such as bedding or buried soil horizons were found in these pits. The surface of the lithified layer in the Lauvie pit has a slope of 10°. Sediment samples were taken in each pit at intervals of 0·3 m. In each pit median sediment size increases with depth, from 1·2 to 1·7ϕ at the surface to 0 to $-0{\cdot}7\phi$ at the bottom. Sorting in the Lauvie pit does not vary with depth (moderately well sorted), but in the Maraunibina pits varies from moderate to very poor quite erratically. Most of the pit samples are finely negatively skewed. These sediment characteristics resemble those of beach sands.

7·2. *Beachrock*

Beachrock is well-developed on the more exposed Marau cays, especially on the south-eastern barrier (Lauvie, Kosha, Tarvarau, Horohato), and is absent on the more protected islands of the inner reefs such as Paipai, Tese, Pelakauro, Quinine and Keura. Small outcrops of beachrock are found on present beaches, without indicating beach retreat, at Niu and Maraunibina. Relict beachrock is also found on North and Symons Islands. No beachrock was seen on unvegetated cays, or on the mainland coast. Because of the high tidal range, beachrock exposures are wider than is usual on many sand cays, reaching 20 m on Horohato.

In each case where beachrock is well exposed it indicates retreat away from the direction of dominant waves, mostly from the south and south-east, but at Lauvie, where waves approach through Southeast Entrance, retreat is from the north-west. Amounts of retreat of windward shores indicated by relict beachrock on flats are as follows: Lauvie 43 m, Kosha 55 m, Tarvarau 76 m, Horohato 46 m, North 70 m, Symons 15 m. Lagoonward retreat of cays as shown by relict beachrock is a universal phenomenon on modern sand cays, and may be caused by the contemporary slight rise in sea level (Stoddart 1962, pp. 109–111). Only small exposures of beachrock undergoing lithification were seen, but most of the relict beachrock is topographically fresh, with well-developed seaward dip and landward scarp. All the relict rock is of intertidal elevation, apart from undermined and drowned older and outer lines, except at North Island, where the rock is slightly higher and much more eroded. The lower parts of the beachrock layers in places serve as a substrate for growing corals, and the rock is everywhere much bored by polychaetes and sipunculids. Gibbs (1969) has described boring by the polychaete *Perinereis* and the sipunculid *Aspidosiphon* at Lauvie Island.

The fact that beachrock is found only at intertidal levels in Marau Sound, in spite of the known tectonic instability of the area, suggests that cay formation is very recent. In spite of the extremely high rainfall it was notable that no water table was found in the pits on Maraunibina and Lauvie, both larger islands than Tarvarau (15200 m^2) where wide beachrock exposures are found. In common with other beachrocks that of the Marau cays is interpreted as the result of cementation by sea-water-drived aragonite (Stoddart & Cann 1965) rather than ground-water-derived calcite (Russell 1962).

7·3. *Conclusions on geomorphic history*

In spite of their location in an area of exposure to the Trades and of topographic diversity and tectonic instability, the Marau cays are unexpectedly simple structures. On the more exposed flats they lie up to 1 km from the reef edges, and are only found close to deep water in protected situations. Hence beaches are almost entirely of coarse sand or fine gravel, and cobbles and boulders are almost absent. Beach ridges are not well developed, there are no interior swampy depressions, and no dunes. Even on the highest reef flats (Symons and North Islands) the islands are similar, though covering a greater proportion of their reef flats. There are no rubble ramparts either on the reef flats or on the cays. This simplicity of form and structure of the cays is inconsistent both with Spender's (1930) interpretation of the effects of reef flat height differences on island form and with Stoddart's (1965) analysis of the effects of changing wave energy conditions on island form in barrier reef areas. Since Marau Sound is also affected by cyclones one would also expect ridges of storm-tossed rubble and boulders, together with gravel sheets on cays, but these are not found (cf. Blumenstock, ed. 1961; Stoddart 1963).

This simplicity contrasts with the complexity of earlier geomorphic history, recorded in the high planed reef flats, the elevated reefs of the mainland coast, and the residual reef-rock of Pelakauro. We conclude that the cays are very recent sedimentary accumulations on much older flats, and that the formation and planation of the reefs took place before the cays in their present form and location accumulated.

8. Conclusion

This study of the Marau cays has confirmed the suggestion that, except in terms of sediment supply, sand cays are related to reef flats in large part only because the latter serve as platforms with depth and dimensions suitable for accumulation under given wave conditions. In this case, where modern reef growth is at best feeble, the reefs as topographic features are relatively old, and the cays extremely young. By comparison with other areas the simplicity of the accumulation features in an area of environmental diversity is difficult to explain.

The Marau cays have partly escaped the massive interference by man which has transformed the vegetation and often the ecological stability of most Indo-Pacific and Caribbean cays. The dense broadleaf woodland extending down to the beaches and the absence of pioneer communities and strand colonizers is the most striking feature of the vegetation. No work could be done on other sand cays in the Solomon Islands, for example those between Gizo and New Georgia, but these appear to be similar vegetationally to the Marau cays.

The sand cays here described do not fit easily into the general schemes of cay morphology proposed by either Spender (1930), Steers (1929, 1937), Fairbridge (1950), and Stoddart (1965). So far as any sequence of development can be suggested, the transformation of ephemeral sandbores into cays by vegetation growth and beachrock formation would account for the features of the Marau cays. This sequence is similar to the evolutionary scheme proposed by Folk (1967) for the cays of Alacran Reef, Gulf of Mexico, but the range of features found on both Alacran Reef and in Marau Sound is so restricted by comparison with other areas that general conclusions on cay morphology and classification can hardly be drawn from either.

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References (Stoddart)

Blumenstock, D. I. (editor) 1961 A report upon typhoon effects on Jaluit Atoll. *Atoll Res. Bull.* **75**, 1–105.

Brenchley, J. L. 1873 *Jottings during the cruise of H.M.S. 'Curacoa' among the South Sea islands in 1865.* London: Longmans, Green.

Brookfield, H. C. & Hart, D. 1966 *Rainfall in the tropical southwest Pacific.* Australian National University, Research School of Pacific Studies, Department of Geography, Publication G/3/1966.

Cloud, P. E., Jun. 1954 Superficial aspects of modern organic reefs. *Sci. Mon.* **79**, 195–208.

Fairbridge, R. W. 1950 Recent and Pleistocene coral reefs of Australia. *J. Geol.* **58**, 330–401.

Fitzpatrick, E. A., Hart, D. & Brookfield, H. C. 1966 Rainfall seasonality in the tropical southwest Pacific. *Erdkunde* **20**, 181–194.

Folk, R. L. 1964 *Petrology of sedimentary rocks.* Austin, Texas: Hemphill's.

Folk, R. L. 1967 Sand cays of Alacrán Reef, Yucatan, Mexico: morphology. *J. Geol.* **75**, 412–437.

Gardiner, J. S. 1931 *Coral reefs and atolls.* London: Macmillan.

Gibbs, P. E. 1969 Aspects of polychaete ecology with particular reference to commensalism. *Phil. Trans.* B **255**, 443–458. (This Discussion.)

Grover, J. C. 1955 Geology, mineral deposits and prospects of mining development in the British Solomon Islands Protectorate. *Interim Geol. Surv. Br. Solomon Isl. Mem.* **1**, 1–108.

Grover, J. C. 1958 The Solomon Islands—geological exploration and research 1953–1956. *Geol. Surv. Br. Solomon Isl. Mem.* **2**, 1–150.

Grover, J. C. 1965 Seismological and vulcanological studies in the British Solomon Islands to 1961. *Br. Solomon Isl. Geol. Rec.* **2**, 183–188.

Grover, J. C. & Pudsey-Dawson, P. A. 1958 Notes on the geology of eastern Guadalcanal. *Geol. Surv. Br. Solomon Isl. Mem.* **2**, 56–60.

Guilcher, A. 1958 Mise au point sur la géomorphologie des récifs coralliens du Nord-Ouest de Madagascar et dépendances. *Mém. Inst. sci. Madagascar* (Série F), **2**, 89–115.

Kuenen, P. H. 1933 Geology of coral reefs. *Snellius Exped. Rep.*, **5**, ii, 1–126.

Pacific Islands Pilot 1956 Volume 1, *The western groups, comprising the Territory of Papua including the Louisiade Archipelago, the north-east and north coasts of New Guinea, the Solomon Islands, the Bismarck Archipelago, and the Caroline and Marianas Islands,* 8th edition. London: Hydrographic Department.

Russell, R. J. 1962 Origin of beachrock. *Z. Geomorphol.* (N.F.) **6**, 1–16.
Sewell, R. B. S. 1935 Studies on coral and coral formations in Indian waters. *Mem. Roy. Asiat. Soc. Bengal* **9**, 461–540.
Shepard, F. P. Curray, J. R., Newman, W. A., Bloom, A. L., Newell, N. D., Tracey, J. I., Jun. & Veeh, H. H. 1967 Holocene changes in sea level: evidence in Micronesia. *Science, N.Y.* **157**, 542–544.
Spender, M. A. 1930 Island reefs of the Queensland coast. *Geogr. J.* **76**, 194–214, 273–297.
Stearns, H. T. 1945 Decadent coral reef on Eniwetok Island, Marshall Group. *Geol. Soc. Am. Bull.* **56**, 783–788.
Steers, J. A. 1929 The Queensland coast and the Great Barrier Reefs. *Geogr. J.* **74**, 232–257, 341–370.
Steers, J. A. 1937 The coral islands and associated features of the Great Barrier Reefs. *Geogr. J.* **89**, 1–28, 119–146.
Stoddart, D. R. 1962 Three Caribbean atolls: Turneffe Islands, Glover's Reef and Lighthouse Reef, British Honduras. *Atoll Res. Bull.* **87**, 1–151.
Stoddart, D. R. 1963 Effects of Hurricane Hattie on the British Honduras reefs and cays, October 30–31, 1961. *Atoll Res. Bull.* **95**, 1–142.
Stoddart, D. R. 1965 British Honduras cays and the Low Wooded Island problem. *Trans. Pap. Inst. Br. Geographers* **36**, 131–147.
Stoddart, D. R. 1969 Geomorphology of Solomon Islands coral reefs. *Phil. Trans.* A **255**, 355–382.
Stoddart, D. R. & Cann, J. R. 1965 Nature and origin of beach rock. *J. Sediment. Petrol.* **35**, 243–247.
Thompson, R. B. 1965*a* Ultrabasic rocks in the Solomons—a preliminary statement. *Br. Solomon Isl. Geol. Rec.* **2**, 33–34.
Thompson, R. B. 1965*b* Nickel: laterite cappings of ultrabasic rocks in the Solomons. *Br. Solomon Isl. Geol. Rec.* **2**, 147–161.
Umbgrove, J. H. F. 1928 De koraalriffen in de Baai van Batavia. *Wet. Meded. Dienst Mijnb. Ned.-Oost-Indie* **7**, 1–68.
Umbgrove, J. H. F. 1947 Coral reefs of the East Indies. *Geol. Soc. Am. Bull.* **58**, 729–778.
Walker, F. S. 1948 *The forests of the British Solomon Islands Protectorate.* Honiara and London.
Whitmore, T. C. 1966 *Guide to the forests of the British Solomon Islands.* London: Oxford University Press.

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FIGURE 112. Marau Sound from the air: Round Island in the foreground, looking south across the northern end of Beagle Island.

FIGURE 113. Marau Sound from the air: the outer barrier, looking south, with Honoa and Horohato Islands on the left and the plunging spurs of Malapa Island on the right.

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FIGURE 114. Thickets of dead *Acropora* exposed on the drying reef-flat surface of Harbour Reef.

FIGURE 115. Meandrine corals bevelled by erosion of the reef-flat surface at North Island.

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FIGURE 116. Simple unvegetated sand cay: Round Island at low spring tide.

FIGURE 117. Exposed reef flat with a narrow sandy beach on the mainland coast at Paruru; Paruru jetty tidal station in the background.

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FIGURE 118. Beachrock on the west coast of Lauvie Island.

FIGURE 119. Beachrock at Tarvarau Island: note the absence of strand vegetation at the top of the beaches.

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FIGURE 120. Wide beachrock pavements at Horohato Island.

FIGURE 121. High-standing beachrock remnants on the reef flat at North Island.

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FIGURE 122. Basalt outcrops on the inner reef flat at Pelakauro Island.

FIGURE 123. Raised reef limestone on the north coast of Pelakauro Island.

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FIGURE 124. Pioneer strand vegetation on a prograding sandspit at Paipai Island.
FIGURE 125. Littoral hedge of *Tournefortia argentea* and *Pandanus* at Lauvie Island.